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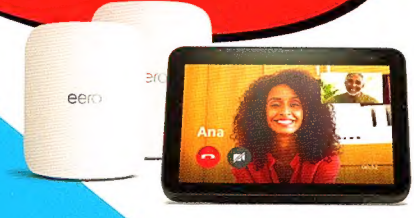

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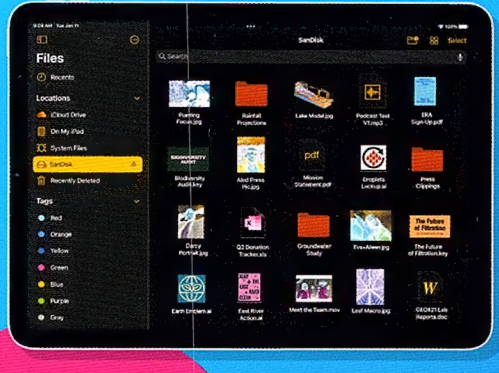

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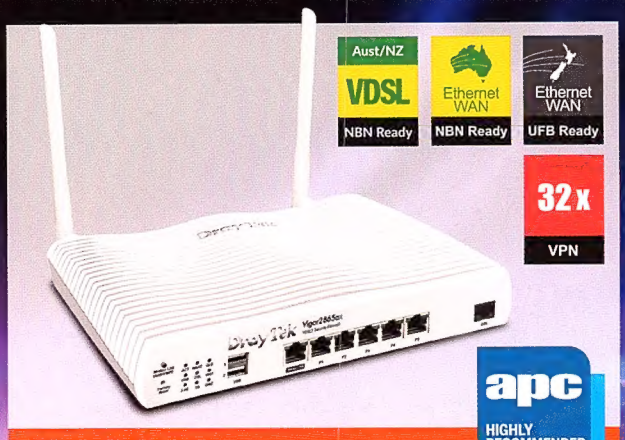

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Tablet time

Take a fresh look at these versatile devices

Tablets are back! After a five year slump that began in earnest in 2015, tablet sales are surging and the last couple of years have shown that these unique devices are very much back in vogue again.

Part of this can be attributed to Apple. The company never gave up on this form-factor, and when the iPad Pro 12.9-inch first appeared it opened up a new world of portable power for traditional laptop users.

Tablets are a nice travelling companion, and you can have a very generous amount of screen real estate in a light and compact package. Battery life for tablets also tends to out-class laptops, and with the addition of a snap-on keyboard you're ready to roll with almost any task.

On the flipside, these keyboards that transform a tablet's useability are still ridiculously expensive, often costing hundreds of dollars. Still, they're what we'd consider optional for most people, with on-screen keyboards usually good enough for anything but an arduously long writing session.

Of course, not everyone needs the size and power of a high-end tablet. For around $400 you can pick up a perfectly useable device that fits a multitude of user needs. That could well be web surfing while you're sitting on the couch, taking notes in a meeting or enjoying BYO entertainment on a long flight. Kids love tablet's too, and it is not a bad thing to say they can be a pretty good babysitter.

If you haven't recently enjoyed the distinct and pleasant advantages a tablet offers over a laptop, it's time to reconsider. I use both, they each have their jobs they do best.

Ands lastly, an apology, in the previous issue I wrote here that APC went onsale on Christmas day. It did not, it actually went onsale on January 5th. I'd misread our schedule and told you all the wrong date, and many subscribers emailed to let me know their issue came late when it arrived in January. My bad! Sorry!

"Tablets are a very nice travelling companion, and you can have a very generous amount of screen real estate in a light and compact package."

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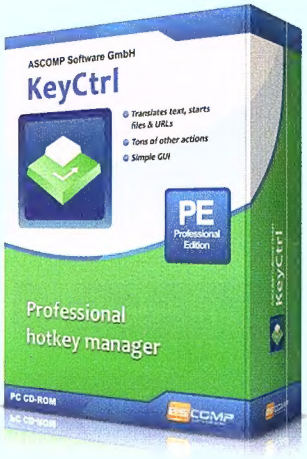

ASCOMP KEYCTRL

KEYBOARD SHORTCUTS FOR ALL TASKS.

Wouldn't it be nice if you could use keyboard shortcuts for all tasks? For example, for the automatic insertion of frequently used texts in the e-mail program or in Word, to translate website content, to take screenshots or to open the most used folder in Windows Explorer? KeyCtrl is the key!

The right key combination and the defined task solve themselves as if by magic. Despite its ease of use, KeyCtrl also offers professional options. In this way, certain hotkeys can only be started when a specific window is displayed or a specified process is running. is loaded.

ASHAMPOO BACKUP 2023

BACK UP AND RESTORE DISK PARTITIONS.

Ashampoo Backup 2023 backs up and restores entire disk partitions, including bootable Windows installations, in just a few clicks. Incremental auto-updates ensure backup files are always up-to-date and prevent data loss. The user interface was designed with simplicity in mind and is intuitively usably by anyone. Backups are always restorable, even in the event of highly corrupt or ransomware-infested systems, thanks to a built-in rescue feature that requires no technical knowledge. This backup software is self-explanatory and streamlined to cover the most essential features so there is no learning curve.

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There are over 100,000 international, national and even regional internet radios from 120 music categories to choose from, listen to and record. Simply select a music genre and the Audials Radio Edition fills the hard drive with music for free! But it can also be recorded radio plays with a timer. The largest podcast database included in a Windows software brings additional entertainment. The Audials Radio Edition records automatically, cuts out the songs from the streams, normalizes the volume of the piece of music, and then stores the pieces of music in perfect music shop quality as MP3 with all ID3 tags and album images on the hard disk.

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NAND suppliers' revenue market share.

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TECHNOTES

Everything you need to know from the month in tech

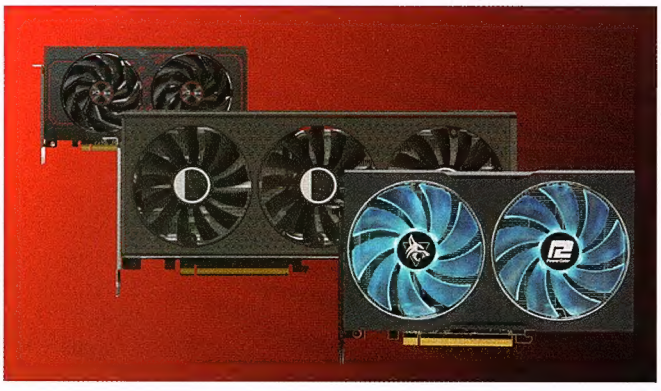
New CPUs, APUs and graphics cards from AMD

The company went big on reveals at CES.

At this year's CES we saw many new announcements, with AMD bringing new APUs, an additional X3D CPU to its range, as well as a budget graphics card.

AMD announced four processors in its new Ryzen 8000G 'Phoenix' lineup of APUs for its desktop AM5 PCs here at CES 2024 in Las Vegas, Nevada, bringing 1080p-capable integrated graphics to the company's newest platform for the first time, not to mention unlocking a new lower entry pricing point to the AM5 ecosystem. The two flagship Ryzen 8000G processors are also the world's first desktop CPUs with an integrated high-performance Neural Processing Unit (NPU) engine to boost performance in AI workloads, beating Intel to the punch again – AMD was also the first x86 chipmaker to bring an NPU to laptops. Now, they've come to the desktop. We'll have reviews in the next issue of *APC*.

AMD's AM4 platform, which has soldiered on since 2017, housing five CPU generations spanning 125+ processors and over 500+ different motherboard designs, is truly the gift that keeps on giving with the arrival of four new Ryzen 5000 models that AMD announced here at CES 2024. The new lineup is headlined by the eight-core 16-thread Ryzen 7 5700X3D, a new 3D V-Cache equipped processor that has all the features of the company's exceedingly popular Ryzen 7 5800X3D, like 96MB of game-boosting L3 cache, but with slightly lower clock speeds. AMD also unveiled the eight-core 16-thread Ryzen 7 5700, again with this model being a less expensive version of its Ryzen 7 5700X. As with their predecessors, these chips don't have an integrated GPU.



AMD has kicked off 2024 for its Radeon line-up of graphics cards with the RX 7600 XT, sporting 16GB of GDDR6 VRAM and minor boosts to the GPU's clock speed. It's still using the same Navi 33 graphics chip as in the original Radeon RX 7600, so there are no additional shaders or memory controllers, though.

That means the new RX 7600 XT has 2,048 shaders and a 128-bit combined memory bus width, but AMD has upped the Game clock by 220MHz (2.25 to 2.47GHz) and the Boost clock by 100MHz (2.66 to 2.76GHz), increases of 9.8% and 3.8% respectively. The VRAM's clocks are unchanged, though, so the transfer rate is still 18Gbps.

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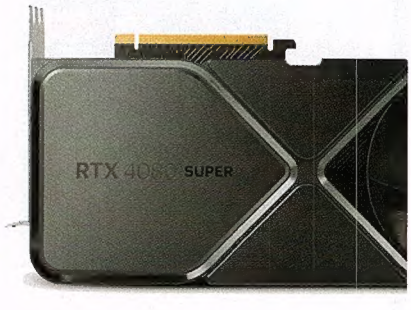

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NVIDIA'S OFFICIALLY ANNOUNCED THREE RTX 40-SERIES SUPER CARDS

IT'S NOT LIKE WE DIDN'T KNOW THEY WERE COMING, EH?

The first of the new Super cards to launch is arguably the most interesting from a pure silicon standpoint – the RTX 4070 Super is the card getting the biggest GPU upgrade, which Nvidia is estimating will deliver up to 20% higher performance. But the one that might just grab the most headlines is the RTX 4080 Super. It's using the full AD103 GPU, which means you're getting all 80 SMs and 10,240 CUDA cores that the silicon has to offer. The weird middle-child – the RTX 4070 Ti Super – is the only one to be sitting on an entirely new GPU. Now using the AD103 chip of RTX 4080 fame, the RTX 4070 Ti Super is getting precisely 10% more cores, from 7,680 to 8,448.

AUSTRALIAN PC AWARDS

The Australian PC Awards are back!

We recognise the very best of the best.

It's that exciting time of the year again, when the team of experts at APC bang heads with fellow experts in the office from our sister pubs *TechRadar*, *PC PowerPlay* and *Tom's Hardware Guide*, and come up with a mighty list of finalists and winners across a huge 27 categories.

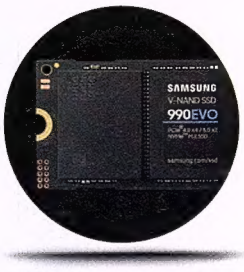
We'll be ranking all the good gear that came out in 2023, covering PCs, laptops, all the nicest components across value and premium categories, networking gear, gaming gear and much more. Plus, our big gongs of the Awards – Excellence (for the person, product or technology that advanced the PC more than any other in 2023), Gold (best company overall) and Epic Fail (self-explanatory, and 2023 has plenty of contenders!).

We'll be announcing all the finalists at **www.australianpcawards.com.au** on February 16th, so head on over and see what we came up with. Then, on March 15th the big winners announcement comes at the same site, and we'll be publishing all the Australian PC Awards finalists and winners, plus a nice overview of the year that was in *APC issue 531* (onsale April 1st).

MSI HAS LAUNCHED A NEW GAMING HANDHELD

FIRST TO LAUNCH WITH AN INTEL CORE ULTRA PROCESSOR.

Following the massive success of the Steam Deck, now it's MSI's turn to show off its new handheld gaming device, and it's called the Claw. The headline feature here is that MSI's new portable gaming device is set to become the first gaming handheld to use Intel's new Meteor Lake processors – the Intel Core Ultra series – up to the Intel Core Ultra 7 155H. That means it'll be making use of the integrated Intel Arc Xe-LPG GPU with eight Xe-cores and a 2.25GHz clock along with XeSS upscaling, which should make it an interesting contender vs the AMD-designed Sephiroth APU found inside the Steam Deck OLED. Speaking of OLEDs... you won't find one here. Instead the Claw will feature a 7-inch FHD 120Hz IPS-level touchscreen display with a 500 nits typical brightness rating.



SAMSUNG'S 990 EVO IS THE WORLD'S FIRST HYBRID PCIE 4.0 X4 AND 5.0 X2 SSD

FRANKENSSD HAS TWO DIFFERENT INTERFACES.

Samsung has accidentally published the product page for its upcoming 990 Evo NVMe SSD, complete with marketing and hardware specifications. The 990 Evo is a firmly midrange drive thanks to its reads and writes of just 5,000MB/s and 4,200MB/s respectively. However, the 990 Evo is unique in its four PCIe 4.0 lanes / two PCIe 5.0 lanes configuration.

Perhaps the 990 Evo's most unique selling point is that it supports PCIe 5.0, but only with two lanes, which is equivalent to the bandwidth of the four lanes of PCIe 4.0 that it also offers. PCIe 4.0 SSDs work completely fine on PCIe 5.0 slots, so there's technically no advantage for the 990 Evo to support PCIe 5.0.

TCL TOUTS FULLY CONCAVE AND 8K OLED PC MONITORS

USES NEW LOW-COST INKJET PANEL TECH.

TCL has announced a slew of monitors due in 2024 with numerous hot new technologies at a display tech conference in China. Arguably the biggest news is its inkjet printed OLED technology, which provides a much-needed alternative to the dominant LG and Samsung OLED panels used in every gaming monitor thus far. TCL is showing off its inkjet OLED tech in two monitors, a 31-inch 4K 120Hz model with a weird convex panel and then a more conventional 65-inch curved monitor with full 8K resolution and 120Hz refresh. The convex model supposedly allows for glasses-free spatial 3D visuals of some kind. Honestly, we're more interested in the fact that it's a 31-inch 4K high refresh OLED that isn't based on Samsung or LG panel tech.

© MSI, Samsung, TCL

NASA patches probes a solar system away

Space agency provides exceedingly long-distance tech support.

Maintaining legacy hardware isn't easy when you're in the same office. It's a somewhat greater challenge when you're updating a computer that is literally on the other side of the solar system.

That was the problem facing NASA recently, as the agency was forced to issue a software patch for Voyager 1, an unmanned probe launched in 1977, just a few days after Elvis Presley died. Getting on for 50 years later, the probe is just about functional while speeding through interstellar space, a mere 24 billion kilometres away.

As you might expect, that old hardware is creaking. Last year, the team noticed a problem with the thrusters that keep the craft's antennas pointed towards Earth. After puzzling over corrupted data, they realised that a build-up of propellant residue was preventing them from firing properly – which if left untreated, could result in Voyager 1 losing touch with us.

Applying the update

Fortunately, the scientists determined that a software update could fix the problem. Modifying how often and how much the thrusters fire would mitigate the residue build-up. The bad news was that applying the software update to both Voyager 1 and its deep space companion, Voyage 2 (which also launched in 1977) would be far from a regular Patch Tuesday, according to Bruce Waggoner, an engineer working on the Voyage programme at NASA's Jet Propulsion Laboratory (JPL).

"They were built at JPL and the machine language they use is a JPL-specific version that people cooked up here," said Waggoner. "It looks similar to other 1970s and 80s opcode architectures you see in processors, but it's a unique set of instructions and the software isn't necessarily well written. It was written by people who were just learning the code like everybody was in the 70s and 80s."

Being half a century old, the system is relatively simple compared to modern standards. And this was both a blessing and a curse for the team working on the software.

"Anytime we patch, we're not doing what you envision with the modern computer," said Waggoner. "We're literally just writing over the bits that we want to change directly. We're doing a poke command, essentially."

Poking around

Exactly how the poke command would be issued was a trickier question – one that required NASA to blow the dust off of its rolodex. "One of our retired software engineers was pulled back in and worked a lot of overtime and hobby time essentially, and figured out what the issue was," said Waggoner.

Before the code was deployed to the ageing probe, it was extensively vetted on the ground by engineers, but testing was also a challenge. "We used to have an actual copy of the flight components in hardware and we could run those with model parameters coming in [but] that was retired decades ago," said Waggoner.

Updates to the Voyager space probes have kept them working despite the almost incomprehensible distance.

However, modern computing did provide one modern convenience. Thanks to improvements in computational power, the retired engineer could build a software simulator to test the code that was significantly more sophisticated than what NASA had access to historically – meaning the team could properly simulate the space environment.

This proved invaluable, because the fix for the thrusters was surprisingly complex code. It wasn't just changing a specific value in the code, but manipulating how the Altitude and Articulation Control Subsystem (ACS) behaved. "The bit of code we were fixing here was actually embedded in some of the timing cycles that run on the ACS computer, and that's what was concerning to us," said Waggoner.

Patch successful

Having tested it thoroughly with the simulator, Waggoner and his team were confident the patch would work successfully by the time the patch was applied. That confidence wasn't misplaced – the patch appears to have landed without a hitch, and now Voyager is continuing to beam back data from the furthest reaches of our solar system.

But as Voyager 1 continues to age, we should probably expect more daring upgrade missions like this one to keep it alive, as more components fail with age. Already, the camera that took the iconic 'Pale Blue Dot' photo has been long out of service. And today, only the more basic scientific instruments continue to function and collect data.

"Every year we have to take more risks," said Waggoner. "Towards the end of the decade, there's some very scary things that we might have to try and so having the simulator is going to be great."

Given how distant the two Voyager probes are, getting a few years more out of both is vital to make the most of the science opportunity. "It's not clear to me that we will ever have two spacecraft outside the heliopause, outside the sun's magnetic influence, at the latitudes they're at for decades or even centuries," said Waggoner.

Although astronomers have access to powerful telescopes both on Earth and in orbit (in the form of Hubble and the James Webb Telescope), Voyage 1 and 2 both do something that these newer devices cannot. "The only true data set, the only in-situ data that we'll ever have for decades is going to come from these two Voyager spacecraft," said Waggoner. "So, it's really a fantastically important data set Voyager's bringing home that won't be replicated for a long, long time." ■

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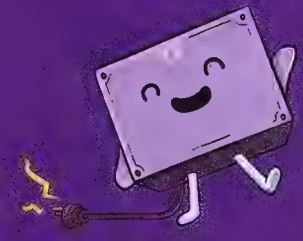

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Leaks suggest Sony is anxious about its games future

PlayStation is a market leader, but the way things are going there can be no certainties, writes Shaun Prescott.

One of the biggest leaks in videogame history hit at the tail end of 2023, when ransomware mob Rhysida leaked a terabyte worth of data stolen from Insomniac Games. The American developer of *Ratchet & Clank* and *Spider-Man 2* had its secret internal communications and data laid bare in public, with some genuinely breathtaking discoveries found inside, including a playable build of its forthcoming *Wolverine* game.

The leaks show that fans of Marvel can rest easy knowing that superhero videogames will keep shipping into the unforeseen future. Which dovetails neatly with another big (though perhaps not surprising) revelation found in the leaks: Sony's anxiety about the future of PlayStation. One presentation belonging to Sony rather than Insomniac (the former owns the latter) explicitly notes that Microsoft's recent Activision-Blizzard acquisition could help Xbox "leapfrog our current pillars", with emphasis placed on the possibility of future *Call of Duty* games releasing onto Xbox Game Pass on day one. This would not be surprising at all: all of Microsoft's first-party games release onto Game Pass like this.

The tone of the presentation belongs to a company that knows it can't keep relying on what it does best: big and gorgeous blockbuster games with supernova development budgets. It appears especially worried about Microsoft's cross-platform harmony across console, PC and mobile, and the value proposition this adds to Game Pass, especially when *Call of Duty* hits the service. One of the driving factors behind Microsoft's acquisition of Activision was the latter's strength in mobile: it acquired *King of Candy Crush* fame in 2016, but also owns the likes of *Hearthstone* and *Call of Duty Mobile*. Sony has no such strength and is clearly worried about Microsoft's plans to compete directly with Apple and Google in the mobile space. Microsoft has designs on sticky, inescapable eco-systems that Sony doesn't appear to have the resources or knowledge to emulate.

"Expectation of free, best-in-class games creates unsustainable model," one note in the slide reads. Sony's PS Plus subscription service doesn't receive first-party PlayStation games on day one like Microsoft. This makes a bit of sense, because Sony appears to invest much, much more in expensive games like *God of War Ragnarok*, *The Last of Us Part 2*, and *Spider-Man*. They call it in their slide a "premium sales model". But that only raises the question: do games like that have a sustainable future? If they don't – if we are facing a future where players are completely averse to forking out AU$125 for new videogames unless its *GTA VI* – then one avenue for Sony is to build a good portfolio of live service games.

But that's not working out so great. The company wanted to bring a whopping 12 live service games to console and PC by 2026 but that's been reduced to six. In December, Naughty Dog announced it has stopped working on the four year in-development *The Last of Us Online*, which is probably the most highly anticipated of the known crop. Sure, Microsoft has failed to produce its own sustainable live service games too, but it at least had a solution: forking out for Activision-Blizzard.

The industry is facing some ruthless, volatile times. 2023 saw around 9,000 layoffs, and given how quickly the scene is shifting, it's hard to imagine there won't be more in 2024. The companies at the vanguard of the games industry have shifted regularly and dramatically throughout the medium's history, but rarely has there been so much money – and so many workers – at stake. ■

Shaun Prescott is an Australian editor for PC Gamer, GamesRadar and PLAY, and writes for APC, TechRadar and more.

Is MSI's AI-powered mini-map tool fair-game?

The SkySight on-screen software tells you where enemies are coming from.v

They say all is fair in love and war, but we're not sure which of these justifications MSI uses for its newest on-screen game assist (potentially-cheat-assist) technology for *League of Legends*. The Taiwanese company has never held back from adding on-screen tools to give its customers every possible advantage in competitive games, but a new tool showcased on the MEG321URX QD-OLED at the 2024 CES seems to get closer to the line of cheating than anything before it.

The new QD-OLED monitor has an on-board AI processor that analyses the game's minimap to alert you when and where any enemies may be coming from. The SkySight feature was demonstrated using League of Legends, but MSI told *Tom's Hardware* that the company will release subsequent software, allowing you to train this feature for any game.

Because the software is analysing visual data that is already available to the player, it's possible that it doesn't break any existing rules for online competitive games right now, but it does seem to be a more direct way of helping players get an advantage than something that simply improves visual game fidelity. Since it'll only be available to those with inbuilt AI processors and, we presume, that running third-party AI software to do the same thing though your PC would be considered cheating, it seems like a feature that's only technically in a grey area.

If AI boosted gameplay like SkySight or the low-light enemy highlighting AI Vision technology is permitted... or at least it's too hard to moderate, then MSI definitely has a marketable feature for improved gameplay. For RTS pros that don't want to be usurped while regulation catches up it's hard to not feel compelled to nab the new tech immediately, but we suspect this feature will be more helpful for novices than for pros anyway.

While this AI tool is controversial, it's not actually even close to being the most interesting (or beneficial) bit of tech in the panel. That award goes to the QD OLED panel since it's capable of a 0.03ms response time – which is almost seven times faster than the fastest 540Hz LCD display: the Asus ROG Swift Pro PG248QP (page 37). According to a study Nvidia did on kill-to-death ratios (which actually seems worthwhile) swapping from a 60Hz monitor to a setup running at 180fps can almost double a player's kill to death ratio, so it's not unreasonable to suggest that the 240Hz MEG321URX and it's ultra-low OLED latency is going to be way better for your gaming performance than SkySight.

Still, it does open the door for even more creative ways to use AI to allow you to get an edge over competitors in PvP titles. Plenty of TVs and monitors showcased at CES used AI to upscale or improve picture quality, which seems like a great use of AI's skills for improving gameplay, but it does make it harder to determine what kinds of ways AI should be able to help gamers improve their performance. ■

"If AI boosted gameplay like SkySight or the low-light enemy highlighting AI Vision technology is permitted... or at least it's too hard to moderate, then MSI definitely has a marketable feature for improved gameplay."

Joel Burgess is one of the senior journalists on APC magazine and apart from being the resident laptop, monitor and fitness tech geek, he's also pretty into surfing his local Sydney beach breaks when he's not in front of a screen.

RTX 4090 banned in China

With attempts to work-around the ban quickly trampled.

Only about a year after the good ship RTX 4090 sailed out the doors, the US Department of Commerce has updated its export controls on various GPUs to prevent them from being sold to China. The RTX 4090 is now deemed too potent, due to its theoretical AI performance. The restrictions went into place on November 17, 2023, and the resulting chaos should come as little surprise.

The latest export restrictions on AI hardware define the limit as anything with a Total Processing Power (TPP) of 4,800 or higher. There's a secondary factor of Processing Density (PD – TPP divided by die size in square-mm) that seeks to limit data centre parts so that supercomputers can't use lots of lower performance parts to make up the difference. Various GPUs, including the Nvidia H100, H800, A100, A800, L40, L4, and RTX 4090, can no longer be exported to China without a license – with a presumption of denial for license exceptions.

TPP is calculated by the highest teraflops or teraOPS throughput multiplied by the number of bits (eg. 16 for FP16 operations). The RTX 4090 has peak performance of 330 teraflops of FP16 compute using its tensor cores, giving a TPP of 5,280. That restricts it from sale – or manufacture – in China. Nvidia's L4 GPU accelerator has a TPP of 1,938 and uses the AD104 die with a 294.5 mm2 die size, giving a PD rating of 6.58, so it's also blocked.

To comply with the new restrictions, Nvidia created new products, but the Department of Commerce seems intent on blocking future parts as well if it deems them too powerful. Take the H20, which has a TPP rating of 2,368 and PD of 2.9, so it just barely complies with the announced limits. The problem is that it still has 96GB of HBM3 and 4 TB/s of bandwidth, so for LLMs (Large Language Models), it's still quite capable. It's almost like the US Department of Commerce didn't define the limits in a sensible way.

Numerous modified RTX 4090 cards – along with 3090 and 3080 cards – are now popping up on places like AliExpress, the coolers replaced by blower-style coolers. In the case of the 3080, the VRAM has been upgraded to 20GB. This allows the use of multiple GPUs in servers, meaning groups within China are aware that it's possible to take consumer parts and turn them into faux-data centre parts. They're also aware that memory capacity is often more important than pure compute for LLMs.

Nvidia is supposedly preparing an RTX 4090D for China that will reduce computational performance to comply with the export regulations, but those restrictions now appear to be a moving target. If an Nvidia L4 data centre part can't be exported to China, why allow RTX 4080 and RTX 4070 parts to be sold? All they need is blower-style cooling, and they could be as capable as the L4.

It's not clear how this will play out, but given most graphics cards are assembled in China, it's potentially a double whammy. Of course, all of this ignores the fact that tens of thousands of H800 and A800 AI compute GPUs are already in China, not to mention even larger numbers of RTX 4090, 4080, and 4070 cards. I can't help but worry that we may be in for even higher GPU prices going forward. ■

"To comply with the new restrictions, Nvidia created new products, but the Department of Commerce seems intent on blocking future parts as well if it deems them too powerful."

Jarrod has been described as an AI by people he meets at parties.

The wrong cards are getting the Super treatment

Nvidia has the opportunity to address its weaker links.

The mid-life refresh of Nvidia's Ada Lovelace generation graphics cards is here! The RTX 4070, RTX 4070 Ti and RTX 4080 are all getting Super updates, but for now, the cards that stand to benefit the most - the RTX 4060 and RTX 4060 Ti - are not. And that's a shame.

Though supremely power efficient, the weak specifications of these cards meant they were viewed less favorably than their RTX 30-series predecessors. Nvidia may have undisclosed plans to update them later in 2024, for now, what you see is what you get.

Perhaps a good way to describe them is 'adequate'. If the RTX 4060 was known as the RTX 4050 and the RTX 4060 Ti was the RTX 4060, and both were priced appropriately, then adequate would not be an accurate descriptor. Such cards could have been something special. Nvidia would have earned rave reviews and positive social media and forum commentary would have given it a year's worth of PR smiles.

The RTX 4060 is actually a very good graphics card that's only let down by its market positioning. The AD107 GPU at its heart is relatively tiny at 119mm². It comes with 3,072 activated shaders, 8GB of VRAM and 128-bit bus. They're not specifications we'd expect from a 2023 mid-range graphics card. Compare those specs to its RTX 3060 12GB predecessor. It uses the 276mm² GA106 GPU with 3,584 shaders, 12GB of VRAM, and a 192-bit bus. The RTX 4060 is a regression in comparison.

It's a similar story for the RTX 4060 Ti. Its AD106 GPU measures in at a still small 188mm². It's got 4,352 shaders, an improvement over the RTX 4060, sure, but it's still stuck with 8GB of VRAM, and 128-bit bus. I'll ignore the $100+ premium for the 16GB version as that's just too much extra.

Compare that to the 392mm² GA104 GPU of the RTX 3060 Ti with 4,864 shaders and a 256-bit bus and again, we're looking at a regression.

Here's what I'd like to see. A future RTX 4060 Super could basically take the place of the RTX 4060 Ti. Equip it with the AD106 GPU, with let's say 3,840 shaders and 16GB of GDDR6 (or even GDDR6X) and you'd have a much stronger card. Nvidia could up the price and I wouldn't complain.

It could do the same with an RTX 4060 Ti Super. Using the AD104 (as the RTX 4070 uses) would be a big step forward. Though the 5,888 shader count of the RTX 4070 is already far below the maximum capabilities of the fully enabled 7,680 of the AD104, a variant with even fewer shaders, plus GDDR6 (not necessarily GDDR6X) with a 192-bit bus would put it much closer to the soon-to-be EOL RTX 4070 than it is to the RTX 4060 Ti non-Super.

Come on Nvidia, throw us a bone. You're making a killing on AI, but your roots are in gaming. We're not expecting charity, but giving mainstream gamers a Super incentive to upgrade wouldn't hurt the bottom line too much.

Would it? ■

"A future RTX 4060 Super could basically take the place of the RTX 4060 Ti. Equip it with the AD106 GPU, with let's say 3,840 shaders and 16GB of GDDR6 and you'd have a much stronger card. Nvidia could up the price and I wouldn't complain."

Chris Szewczyk has been elbow deep in PCs since before the turn of the millennium, and he wouldn't have it any other way.

It's not just a game, anymore

We're to blame when our AI overlords arrive.

Nvidia is currently selling AI chips at a rate of about $15 billion every three months. By 2027, analysts predict that this figure will have doubled, taking annual revenues to about $200 billion, again for those specific chips used in data centres and excluding other income like gaming GPUs.

But as clever as Nvidia's CEO Jensen Huang is, it's a bit of an accident. The AI chatbot revolution, the whole large language model thing, is thanks to PC gaming – at least it is as far as Nvidia is concerned. Almost everything about Nvidia's AI boom is kind of fascinating. It's intriguing, for instance, to consider who Nvidia's biggest customers are. You probably already knew that Microsoft was big on AI, so the fact that it's thought to have bagged no fewer than 150,000 of Nvidia's H100 AI-optimised GPUs in the most recent three-month period at a cost of around $5 billion isn't a huge surprise.

But did you know that Facebook is reckoned to have bought just as many? In both cases, it's three times as many H100 GPUs as Google and Amazon, who are each estimated to have bought about 50,000 units.

Their relatively lower uptake is probably related to the fact that they both commission chips of their own that do some of the work when it comes to processing AI workloads. With the eye-watering unit prices Nvidia charges for its H100 GPUs, thought to be $20,000 to $40,000 each, you can understand why the likes of Google and Amazon have decided, at least in part, to do their own thing. You also have to wonder if Nvidia's punitive pricing will end up hurting the company if everybody decides it's cheaper to make their own AI chips, or if the huge cost of Nvidia GPUs encourages customers to give alternatives like AMD's new MI300 a crack.

Even if there are legitimate questions over pricing, Nvidia has done an amazing job. It's turned the company into a tech juggernaut. But don't go thinking that it's all part of a grand plan. 20 years ago, it wasn't talking about AI. It wasn't even talking about it 10 years ago. Ultimately, it's serendipitous that the highly parallel nature of graphics chips lends itself so well to machine learning and large language models. That wasn't Nvidia's plan back when the company was founded in 1993.

If it was, they kept it secret through those days of Riva and then GeForce graphics products. It was all about graphics, with barely a word about general computing, let alone AI. When Nvidia did eventually pivot to pitching its GPUs for general-purpose tasks beyond graphics, it was things like physics modelling, protein folding, and video encoding that were pointed to as killer apps for so-called GPGPU workflows, not AI.

Here we are in 2024, with dramatic strides being made, and I can't help thinking it wouldn't be happening, at least not right now, were it not for video gamers, and in particular PC gamers. It's us PC enthusiasts that drove demand for ever more complex GPUs. For better or worse then, whatever marvels or horrors the coming revolution holds, we only have ourselves to blame. Together, we are the parents of AI, and our offspring will change the world. ■

"Ultimately, it's serendipitous that the highly parallel nature of graphics chips lends itself so well to machine learning and large language models. That wasn't Nvidia's plan back when the company was founded in 1993."

Jeremy has a black leather jacket just like Jensen's.

The slow lane

Old thinking, old production methods and old tech won't wash in 2024, says Jon Honeyball.

Here's a scenario that may sound familiar. An industry in turmoil due to a Big Change, with the market rapidly switch to a new technology. Small, nippy companies native to this new tech are emerging while the big players are acting like dinosaurs in their slow, clumsy attempt to adapt to a new business reality.

For once, I'm not talking about IT. I'm talking about cars. The shift to electric is happening in real-time, and the vendors are having a tough time making it work.

Things are sufficiently bad that, a few months ago, Volkswagen started a three-year cost-cutting programme designed to save ten billion euros. CEO Thomas Schäfer told managers that "the roof is on fire". Then, before Christmas, the HR board member Gunnar Kilian said: "We need to finally be brave and honest enough to throw things overboard that are being duplicated within the company or are simply ballast we don't need for good results".

At the cheaper end of the scale, a slew of new Chinese manufacturers are arriving in the market at prices that European car makers can't hope to compete with. Then there's Elon Musk. Put aside your personal feelings about the man, and it's clear that Tesla has had a vision of design and deployment that leaves everyone else in the dust. Build quality might not always be brilliant, but Tesla had the guts to do something profoundly new. Just like Apple introducing the iPhone. Or betting the farm on the move from Intel CPUs to ARM.

To clearly see how far behind the European manufacturers are, just look at the Tesla Cybertruck. Ignore the Thunderbirds styling and look instead at the engineering. It's a fully 800V power train – this isn't unique, with Porsche, part of Volkswagen Group, launching this in the Taycan back in 2019, but the internal wiring is. Tesla has moved away from the ancient 12V power system with the slow CANBUS interconnects, and moved to 48V and Ethernet. Quadruple the voltage and you quarter the current. Drop the current and you need smaller, lighter and cheaper wires. And the resistive losses are commensurately lower too.

You can't do this if you have a huge production structure based around 12V. Don't forget that Volkswagen Group is just the top of the pyramid: there are thousands of component suppliers working to the 12V standard, all of whom feed into the mothership company.

Rather than tackle the problem head on, the big German manufacturers have retreated into a hole of backward thinking, poor implementation and some dreadful UI, software development and business decisions. Anyone want to pay BMW a monthly subscription to enable the heated steering wheel in its new car? No, I thought not.

This type of slothful, ignorant thinking has landed European car manufacturers in this mess, and it's hard to have sympathy. The next few years are going to be rough for BMW, Volkswagen and others, akin to the switch from GSM phones to smartphones. Remember how Apple has ended up with all the profits for the entire sector, almost wiping out incumbent Nokia in the process? The same will happen in electric cars. Tesla has done an Apple on the European car industry. China is doing a Samsung.

If this analogy doesn't compute with the car makers, let's try another: fossil fuels are called fossil for a reason. Lazy thinking dinosaurs are destined to die. ■

"To clearly see how far behind the European manufacturers are, just look at the Tesla Cybertruck."

Jon Honeyball is still running a ten-year-old Audi with 170,000 kilometres on the clock. And will do so until it drops.

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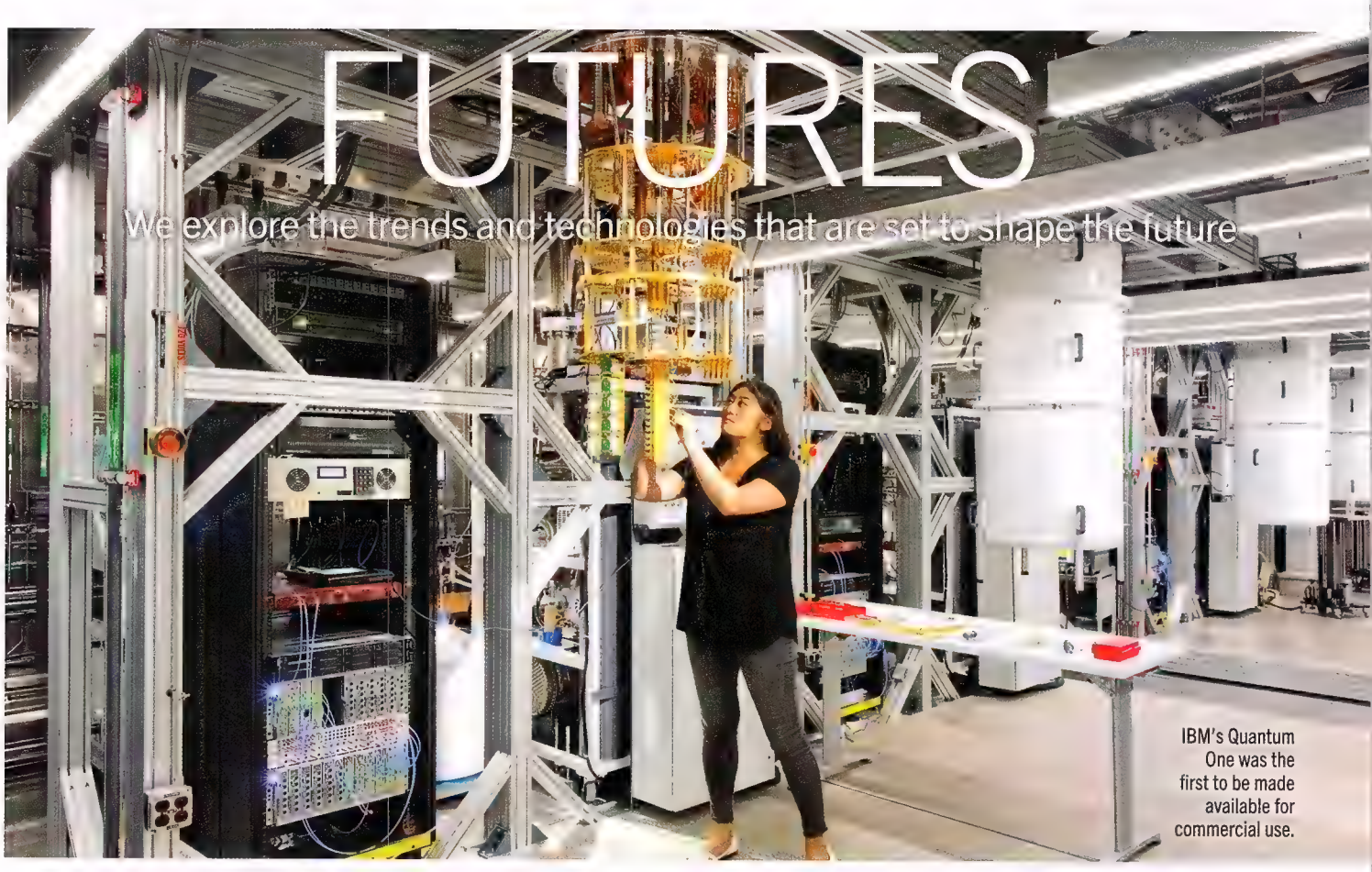
FUTURES

We explore the trends and technologies that are set to shape the future



IBM's Quantum One was the first to be made available for commercial use.

Quantum computing is here... with one small caveat

The UK government is backing 30 projects to kickstart quantum technologies, even though the hardware isn't ready. Nicole Kobie meets one company mitigating the effects of climate change to find out why.

Quantum computers are only just edging into useful existence, but the world isn't willing to wait for the technology to mature. They're already being put to good use in finance, energy production and manufacturing – and soon, if all goes well, quantum systems will predict potential flood damage to help plan mitigations against the impacts of climate change.

Multiverse Computing is leading one of 30 projects backed by the UK government as part of efforts to develop quantum technologies for public sector applications. Alongside its partners, Oxford Quantum Circuits and Moody's Analytics, Multiverse is developing an algorithm to optimise neural network outputs for more detailed flood modelling.

This is part of the government's Quantum Catalyst Fund, a £15 million pot of cash to encourage quantum technologies to be developed for public use. Multiverse's project was handed a slice of that money for a three-month feasibility study as phase one of the fund, with contracts doled out for any promising ideas as part of phase two, in which they'll be asked to make a prototype or product demonstration.

That £15 million is just the start. The fund is part of a wider National Quantum Strategy published in March 2023 that will see £2.5 billion invested in the next ten years. The belief is that quantum technologies could offer solutions in healthcare and energy infrastructure. And – through quantum clocks and communications – it could help railways, emergency services and telcos step away from satellites to a more secure alternative.

But given quantum computers remain very much a work in progress, how can anything get done? Enter hybrid quantum computing.

What is quantum computing?

Let's step back to basics. Classical or traditional computers make use of on/off transistors, with data stored in bits that are either a one or a zero. Quantum computers differ by taking advantage of quirks of physics, in particular quantum superposition and entanglement. So a qubit – a quantum bit – can be on or off, but it can also be both; this is superposition. That means data can be processed in parallel. The second property is entanglement, which means the state of a qubit can be related to another, and this enables advanced algorithms.

This means quantum computing could enable advanced modelling or maths that we can't do now. But there are challenges. Reading the state of a superposition qubit isn't really possible, so it drops back to a one or zero, meaning the final result requires further processing to unpick; that

means more processing power is needed, not to mention software to do the work. Another challenge is decoherence: quantum computers interact with their environment, and that can disrupt data and calculations, corrupting results. Mitigating that requires complex error correction.

There's a further challenge: actually building a quantum computer. They do exist now, but with a limited number of qubits. The IBM Quantum One was the first such device to be made available for commercial use, but it only has 20 qubits. Back in 2019, Google claimed it had achieved quantum supremacy – performing a calculation that a supercomputer couldn't do on a human timescale – using its Sycamore device, which had 53 qubits. And in December 2023, IBM revealed its Condor quantum computer with more than 1,000 qubits.

We don't really know how many qubits are required to do the work we'd like quantum machines to do as it depends on the task, but thousands or even tens of thousands could be required for the applications being dreamed up. It also depends on the type of quantum computer, as there are different designs, from superconducting machines like those made by Google and IBM to photonic designs. These use neutral atoms, trapped ions and quantum dots.

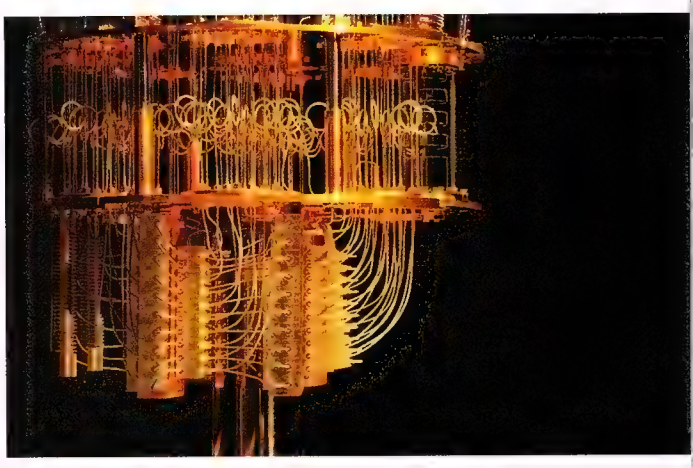
"Each of those architectures has several benefits and drawbacks, so right now it's not clear which of those architectures is going to be the one that scales," Victor Gaspar, head of business development at Multiverse, told *APC* (for this project, Multiverse Computing is working with Oxford Quantum Circuits, which uses a patented three-dimensional scalable design called a "coaxmon").

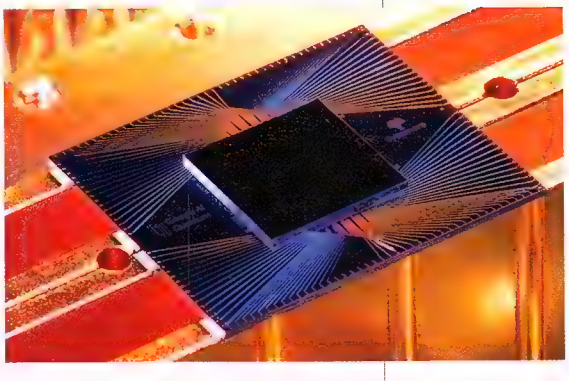
Quantum computers aren't designed to take over from the laptop on your desk or the smartphone in your pocket. Instead, they're a specific tool that works well for some applications, be it maths problems, cryptography or simulations. Making use of quantum hardware requires algorithms written specifically for such computers – and that's part of the reason hybrid systems have appeal. We need to develop quantum computers and the software and algorithms to run on them in concert.

The key takeaway on all of this is that quantum computing isn't quite here yet and it's not easy to build.

Hybrid today

Though we as yet lack quantum computers at a practical level – they exist, but largely in labs, and not in the form required to do everyday work – we can make use of quantum ideas and more limited quantum hardware by combining it with classical algorithms and computers.





TOP Machines are being built that can use entanglement and superposition effects.
ABOVE Google claimed it had achieved quantum supremacy in 2019 with Sycamore.

"A quantum algorithm is like a classical one but uses several phenomena that are quantum that you don't have in a classical computer," Gaspar said. "For example, entanglement and superposition... We are currently building machines that can make use of those effects."

To an extent, it follows the development pattern of traditional computing, Gaspar says. At first, algorithms ran sequentially on a single CPU; then a second CPU allowed for parallel computing. "Now we are developing a technology that has several properties that are not in classical [computers] that you can make use of for developing new algorithms," Gaspar said.

And that takes time, he notes – after all, many of the most famous algorithms in use today were developed in the 1980s, and we're still coming up with new ways to get the most out of classical computers. That's one reason why it makes sense to start developing software and algorithms for quantum computers when the hardware isn't quite ready yet, as it's going to take years or decades to really get to grips with these weird new machines.

Multiverse Computing has an algorithm that will work with the project in question, but one of the first steps will be to optimise it for the hardware being supplied by project partner Oxford Quantum Circuits.

Floods of data

This particular hybrid quantum project seeks to better model the potential for flooding, especially as the climate crisis exacerbates the risks. The aim is to understand where and when to expect floods, and better predict their impact on surrounding areas, be it homes, transport networks or infrastructure. However, computational fluid dynamics are notoriously complicated, and the challenge is exacerbated by the need to pull in a lot of data to improve the accuracy and granularity of a model.

Multiverse Computing and its partners will use shallow water equations, a subset of computational fluid dynamics, to model bodies of water including rivers and the ocean. "In classical computers this has a really high computational cost for simulation, especially for large areas in a high resolution," said Gaspar. "If you want to model a huge mass of land that intertwines with a huge mass of water, and you want high resolution with buildings and coastal features and all that, it's highly complex."

For example, a modelling system could choose to ignore the impact of windows on flood effects, but a more detailed simulation might include windows. "We want to proceed in precise detail," Gaspar explained.

Multiverse Computing is going to help address that computational challenge by adding a quantum circuit into the neural network architecture to optimise the system and improve training performance while also reducing memory consumption. That will use Oxford Quantum Circuits' 32-bit quantum circuit.

The system will also be able to increase the expressivity of neural networks, which refers to how such a deep learning system approximates functions for better predictions. And, when more qubits are available, this system will be able to scale up to boost the neural network for better accuracy.

Hybrid quantum computing and healthcare

Hybrid quantum computing could have a particularly big impact on healthcare, with Professor Katherine Royse stating at an IBM event that drug discovery, diagnosis and vaccine creation can all be made quicker through techniques available today.

Professor Royse, who is director of the Science and Technology Facilities Council's Hartree Centre, says this isn't theory. "For drug discovery, for example, we are finding that it is picking molecules better than a classic system would do," she said, referring to a mix of IBM's quantum computers, classical high-performance computing and AI.

Although she emphasised that all this work was still at the proof-of-concept stage, she added that hybrid quantum computing was also producing results in cancer diagnosis – detecting not only that cancer was present but what type of cancer it was, with a stunning 70% accuracy level.

"Next time we have something like a global pandemic like Covid we've already proved that using hybrid workflows would have come up with drugs that are potential treatment pathways more accurately than we did on the classic process. And that was a speed up compared to what we'd ever had before."

Professor Katherine Royse (centre) believes hybrid quantum computing will help us tackle future pandemics.

Practically, the neural network output feeds into the variational quantum circuit. That means the neural network must be designed in the right way for the output to match the quantum gates. That quantum circuit offers a result that is measured, and that measurement is then input back into the neural network.

"Essentially what we're trying to solve is an optimisation problem at the end of the day, to simulate the effects of these floods," said Sam Mugel, chief technology officer at Multiverse. "And for this optimisation problem, we're going to solve it on a quantum computer using these variational quantum algorithms."

The challenge is that the quantum computer is small, with just 32 qubits, but the problem is very large, with millions of variables. "The trick we're going to do is we're going to use a neural network architecture to compress the information," Mugel said. "We have input, we're going to compress it, run this on the QPU (the quantum computer), run the optimisation problem on the QPU, and then run it back through [the] neural network to decompress it."

There's plenty of work to do first. In the initial phase of government-funded work, Multiverse Computing is proving the project can succeed – it's effectively a feasibility study. That requires understanding the nature and structure of flood data and how it needs to be processed so it can be used to train the neural network, but also showing how the hardware and software will work together.

"What we want to show in phase one is that... larger quantum circuits will be able to solve problems that can't be solved with classical computing," Gaspar said. If approved by DEFRA for phase two, Multiverse Computing and its partners will shift to implementation and building a working prototype.

Long road ahead

So if a 32-qubit circuit isn't enough to run an entire algorithm, how many qubits do we need? Gaspar says we simply don't know, and nor do we know how long it will take to build large enough quantum computers.

It's a chicken and egg situation: we need software to show what the hardware can do, but it's difficult to develop software when the hardware doesn't exist yet. And that's why hybrid quantum makes sense: it lets us see the value of quantum computing now, expand our simulation and modelling without waiting for larger quantum machines, and allows us to start developing the associated technologies such as software and algorithms so we're ready to go when the hardware can be properly scaled up.

"If you think about it, the semiconductor industry has been around for 70 years," said Gaspar. "I'm not going to say quantum computers are going to take 70 years, but we need the technology to develop. And right now we are at the stage where we need to be clever in how to design those algorithms and do more hardware crossover designed to make the most out of these scarce resources."

Hybrid quantum means we can get some results now. But full quantum computing will first need serious technological breakthroughs – and serious cash. "Before we can justify that level of investment, we need to be able to say that we know when we arrive at this level, we'll be able to solve this type of problem better," said Mugel.

Like Gaspar, he points to the long history of chips. "The semiconductor industry has had trillions poured into it, but before we went ahead and poured all that money into it we first started with transistors," he said. "Applications with very, very few transistors showed that there was value. Once we showed the initial disruptive use case, from there we were able to justify all the investment. For us, I think this project is one of several where we really are seeking to show that for quantum computers."

In other words, this project isn't just about water flow simulation, though anyone living in an area prone to floods will welcome better predictions. Instead, it's a way to test if quantum computing is worth all the effort – and to spark investment in a technology that could be the next revolution in computing. ■

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The A-List

The best products on the market, as picked by our editors.

Premium laptops

Apple MacBook Pro 16in (M3)

STUNNING CREATIVE POWER

A reasonable processor upgrade to device with an impressive screen and unparalleled battery life. The new M3 3nm processors is more efficient, so you'll be able to run the same tasks as the M1 using half the power draw, which helps battery life.

From $4,299, apple.com/au

THE ALTERNATIVES

ASUS VIVOBOOK PRO 16X OLED
This 2023 update has some impressive features for the price and is a surprisingly powerful creative workstation with a stunning screen.
$3,199, asus.com

APPLE MACBOOK AIR
The MacBook Air M2 looks like a standout to us. A powerful and quiet ultraportable with an unbeatable battery life and a great pro display.
From $1,799
apple.com/au

MICROSOFT SURFACE PRO 9
APC rates the Intel model highly, the SQ3 model less so. With Intel, you get a solid upgrade to the world's leading detachable tablet laptop.
$1,547
microsoft.com

Business laptops

Lenovo ThinkPad X1 Carbon Gen 11

BUSINESS CLASS

Fight past Lenovo's opaque pricing – another flash sale, really? – and you'll find a slim, powerful and long-lasting laptop for a competitive price. With a wide range of available configurations, all based on Intel's 13th generation Core chips, this is our top choice for all sizes of business.

From $2,086, lenovo.com

THE ALTERNATIVES

DELL LATITUDE 7340
This 1.1kg laptop offers terrific battery life and, if you choose the better non-touchscreen (look for 400 nits of brightness in the specs).
$2,475
lenovo.com/au

ACER TRAVELMATE P6
Not the most powerful due its 11th gen Core chip, but a great 14in screen and keyboard, superb battery life and competitive price lift it above rivals.
$2,179
acer.com

HP DRAGONFLY G4
It's not the fastest machine you can buy, but otherwise this 1kg masterpiece is as close as you're going to get to the perfect business laptop for executives.
From $2,950
hp.com

Gaming laptops

Razer Blade 15

A SUPERBLY ENGINEERED GAMING POWERHOUSE

Right now there's just not another better value gaming unit around. It's miraculously thin considering the beefy components inside, thermals are very well managed and the Razer Blade 15 manages to extract very good performance from its GPU without undue throttling. There are many variants and options, and they're an outstanding buy if you find one on sale.**From $3,899, razer.com/au-en**

THE ALTERNATIVES

LENOVO LEGION 5I PRO (16IN)
A great-value gaming laptop that's extracts the most from its powerful components. We really love the keyboard, too.
$3,899
lenovo.com/au

NEW **ACER NITRO 5**
The budget gaming laptop king returns with another explosive device for those on a shoe-string. A well rounded budget laptop at an unbeatable price.
$1,599
store.acer.com

ASUS ROG STRIX SCAR 18
It's expensive, but if you want an 18in laptop that delivers all-out power this is the no-compromise 3.1kg beast to buy – it packs quality everywhere.
From $4,599
asus.com/au

Everyday laptops

Asus Zenbook S 13 OLED

ASUS AND INTEL TEAMED UP TO BUILD A MACBOOK AIR KILLER

A compact and budget friendly Ultrabook that's the best available device for many on-the-go professionals. Compared to the MacBook Air 13, it has an additional HDMI and USB-A port, an SSD that's roughly twice as fast, and the screen is brighter and offers rich OLED contrast.

$2,099, au.store.asus.com

THE ALTERNATIVES

MICROSOFT SURFACE LAPTOP GO 2
Runs cool and quiet, and has up to 30 percent better battery life than its predeccessor, all in a beautifully designed form. From $1,199
microsoft.com

APPLE MACBOOK AIR 15
An awesome plus-size MacBook Air with great battery life and graphical performance. GPU performance and battery life are the standout perks here. From $2,199
apple.com/au

HP PAVILION 14
This slim 1.4kg laptop is a superb choice for anyone on a tighter budget. it struck an excellent balance between speed and battery life – around ten hours. From $949
store.hp.com

Chromebooks

Asus Chromebook Flip CX5

The best big-screen Chromebook we've tried, with a bright 15.6in Full HD display with decent black levels and surprisingly rich colours. And it's a good specification for the price, with a Core i5 processor, 8GB of RAM and a 256GB SSD in tow. **$1,179, asus.com/au**

Lenovo Flex 3i Chromebook

This isn't the most powerful Chromebook, but students need reliability more than power – especially if they're only really using it for homework, note-taking, and perhaps the occasional bit of Netflix.
$367, lenovo.com/au

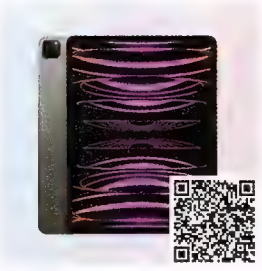
Lenovo IdeaPad Duet

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice.
$297, lenovo.com/au

Tablets

Apple iPad Pro 12.9in

Blurring the boundaries between laptop and tablet like never before, the M2-powered iPad Pro 12.9-inch is every bit as fast as we expected – and the Liquid Retina XDR display is simply phenomenal.
From $1,899, apple.com/au



NEW OnePlus Pad

The OnePlus fully justified its place in our luxury tablet Labs thanks to its outstanding build quality, slick performance and stunning 17-hour battery life. It's the best Android option outside of Samsung's Galaxy Tabs – and it won't do nearly so much damage to your wallet.
From $749, amazon.com.au

Samsung Galaxy Tab S9 Ultra

This 14.5in tablet offers a size and versatility that even the iPad Pro can't match, with its high price more than justified by the quality of Samsung's AMOLED panel, speakers and productivity software.
$1,999, samsung.com

Everyday monitors

MSI MEG 342C QD-OLED

Quantum Dot technology combines with an OLED self-emitting panel to offer brighter, more efficient and more colourful visuals than your average OLED screen.
$1,799, msi.com

Eizo FlexScan EV2480

Businesses in particular will love this easy-to-roll-out 24-inch monitor, with its exceptional five-year warranty, USB-C port for easy docking, excellent viewing angles and delicious whites. And it has the best OSD around.
$619, eizoglobal.com

Dell S2721DS

The Dell S2721DS is a solid and affordable QHD monitor that'll suit general users and casual gamers alike. It boasts a gorgeous 27-inch 1440p display, a 75Hz refresh rate, and a vivid IPS panel that hits 99 percent of the sRGB color gamut.
$319, dell.com.au

Professional monitors

Eizo ColorEdge CG319X

As the price indicates, this monitor is for heavyweight creatives who demand the best in every discipline: HDR video editing, print layouts, professional photography and more besides. With superb coverage and accuracy across all spaces, plus a built-in calibrator, it justifies the investment.
$7,199, eizoglobal.com

BenQ PD2725U

By no means a cheap 4K 27-inch monitor – unless you compare it to the Eizo – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup.
$1,399, benq.com

Asus ProArt PA279CRV

Asus's new 4K productivity panel delivers near pro-levels of performance and precision, though its HDR capability is inevitably limited. What you get is Asus's usual high levels of build quality, plus extras, including essential HDR support and a stand that includes rotation into portrait mode. $799, **asus.com**

Home office printers

NEW Epson EcoTank ET-2810

Don't expect flashy features, but do expect fast print speeds, high-quality prints, scans and copies, plus phenomenally low running costs – even after you've exhausted the 6,000 pages' worth of bottled ink that comes with it.
$399, epson.com.au

NEW HP OfficeJet Pro 9012e

So long as your print volumes aren't huge – the running costs mount up – this is a superb all-in-one for home office usage. It's fast, robust, prints double-sided and produces strong all-round results.
$228, canon.com

Brother MFC-J4540DW

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years.
$329, brother.com

Find the best deals on new gear at **getprice.com/au**

Wireless routers

Synology WRX560
Its quad-band Wi-Fi smashed-through our performance tests managing 791.5Mbps up close, 375Mbps two rooms away and an amazing 216.7Mbps down the garden.
$419, synology.com/au

Asus ROG Rapture GT-AX16000
The most splendid, overpowered router on the market. But, it's silly money and aspirational to most users. Ultimately, though, it's currently the highest-spec consumer router available.
$999, asus.com/au

NEW Netgear Nighthawk RS700S
Make no mistake – you won't get stunning speeds out of this Wi-Fi 7 router today. But if you must buy a router now and want future-proofing, this is a solid choice. But honestly, we would recommend that you wait.
$1,499, netgear.com

Mesh Wi-fi

TP-Link Deco XE200
There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack should be enough for most premises.
$1,299 (2-pack), tp-ink.com

TP-Link Deco X20
The Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 for the price of some standalone routers. The HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth. **$227 (2-pack), tp-link.com**

Asus ZenWiFi AX
The interface and design certainly aren't the prettiest (the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect.
$939 (2-pack), asus.com/au

NAS servers

QNAP TS-130
An above average CPU and RAM combo, solid features and affordable price make the QNAP TS-130 worth considering. Alternatively there's the two bay TS230 which features the same CPU, with 2GB of RAM, dual drive bays, and an extra USB port on the front for a modest ~$50 price increase. **$199, qnap.com**

Asustor Nimbustor AS5304T
This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility. **$679, asustor.com**

Synology DiskStation DS1522+
At $1,199 it's not cheap but factoring in the software means it's great value. Though some internal silicon may lack headroom, this is still a well-featured, expandable NAS with fantastic software. The best part is the DSM software.
$1,199, synology.com

Security software

G Data Total Security
A suite for power users with a host of useful features that offers formidable protection against viruses.
US$49.95, 1 device, gdatasoftware.com

THE ALTERNATIVES

AVAST ONE ESSENTIAL
The only product in our tests to score a 100% protection rating for blocking all malicious files, this reliable choice is our pick of the free AV tools and includes a free if limited VPN service.
Free, avast.com

MCAFEE+ ADVANCED
A high-end choice with high-end features and support for an unlimited number of devices. Good value for the first year, but watch out for renewals.
$139.95, individual, unlimited devices, mcafee.com/en-au

NordVPN
NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates.
$59 per year, nordvpn.com

THE ALTERNATIVES

PROTONVPN
ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options.
Free, protonvpn.com

SURFSHARK
A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services.
$79.61 for one year, surfshark.com

Bitwarden
Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge. **Free, bitwarden.com**

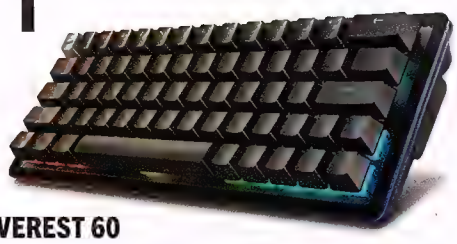
THE ALTERNATIVES

DASHLANE
A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan ($60 per year) as this extends the service to six people.
$55.99 per year (Premium), dashlane.com

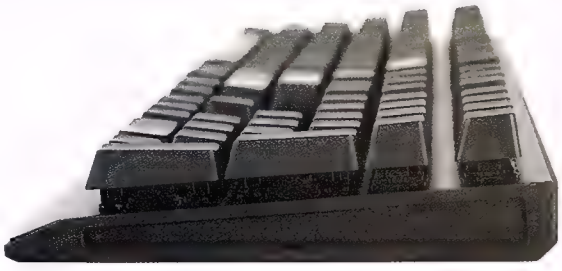
1PASSWORD
1Password is targeted at users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials. **$54.99 per year (individual), 1password.com**

THE LIST

The best gaming keyboards



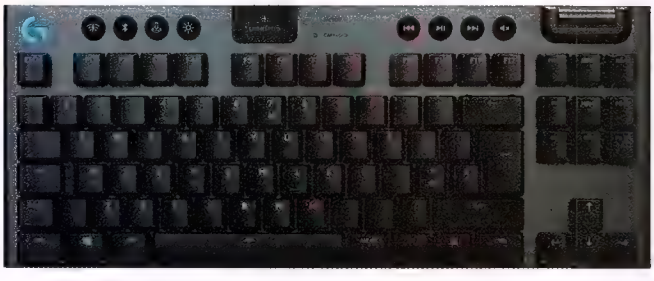
Not all gaming keyboards are created equal. What type of keycaps do you prefer? There's also the question of those all-important switches – do you like clicky or quiet, cushy or crisp? What about size, form factor, and extras like media controls and volume wheels? Do you want all the number keys, or as compact a keyboard as humanly possible? Don't forget about the wired versus wireless conundrum. Yes, there's plenty to consider when choosing your next input slab. Here are five of the very best...



5 WOOTING TWO HE

Look at the black faceplate and keycaps of the Wooting Two HE, and you might wonder what the fuss is about. It looks decent, but doesn't appear too different from most mechanical gaming keyboards. But it is, and then some, because it offers fully analogue key control. If you depress a key, rather than send an on/off signal to your PC, the keyboard will measure the full range of motion. That's great for games like *GTA V*, where you often switch between running, driving, and even flying. **$277, www.wooting.io**

> "If you depress a key, rather than send an on/off signal to your PC, the keyboard will measure the full range of motion."



4 LOGITECH G915 LIGHTSPEED

The wireless Logitech G915 is a dream to type on. It comes with low-profile keys for a comfortable wrist angle, which makes all the difference. The 40-hour battery life with RGB per-key lighting (a little up from the full-size G915 due to the lack of RGB LEDs) keeps Logi's wireless tech in the good books, too. That's actually a 135-day battery life without lighting enabled, but who's counting? As a tenkeyless board, it's also pretty portable, and has a handy slot for storing the wireless dongle. That's a nice touch. **$269, www.logitech.com**

3 MOUNTAIN EVEREST 60

We're still not sure about 60 percent size keyboards for daily use. The Mountain Everest 60, however, is just as small and cute as the competition, and has all the enthusiast extras you could want, but has the total utility to be your daily driver of a keeb. In short, pun intended, Mountain has taken all it's learnt from its first keyboards, and created the best-feeling, most usable 60 percent gaming keyboard ever. It's solid, reliable, responsive, and offers the best typing experience around. **$149, www.mountain.gg**

2 G.SKILL KM250 RGB

The KM250 is an outstanding entry-level gaming keyboard, with the versatility to become almost an enthusiast typing board for less than the cheapest barebones kit. Mechanical gaming keyboards can cost a fortune – the G.Skill KM250 RGB's best trait is that it doesn't. Yet, it still offers mechanical switches, per-key RGB, hot-swappable keys, and discrete media controls. That's incredible for such a low price. **$102, www.amazon.com.au**

1 ASUS ROG STRIX SCOPE II 96 WIRELESS

There are faster, smarter, and cheaper boards that still deliver plenty of features, but the best all-round gaming keyboard has to be the Scope II 96 Wireless. That's in part thanks to lubed switches – yes, lubed switches in a mainstream keyboard. Every key drops lightly into place as you type, and smoothly springs back with a satisfyingly light clack. Wonderful. Lubed up, sturdy stabilisers also keep the larger keys, namely the spacebar, quiet. Delightful. **$269, www.asus.com**

> "Every key drops lightly into place as you type, and smoothly springs back with a satisfyingly light clack."

GOOGLE CHROME | NEEDS Any PC running Windows 10 or later. **PRICE** Free, partially open-source
MOZILLA FIREFOX | NEEDS 1GHz processor, 2GB RAM, 500MB HD space, Windows 10 or later.. **PRICE** Free, open-source

Google Chrome *vs* Firefox

One's a behemoth, the other an old(er) pretender. Nick Peers compares.

When it comes to browsing the web, more than six in ten of us use Google's Chrome browser. Its dominance has slipped slightly in recent years, but that only tells part of the story. Beneath Chrome's hood is Google's open-source Chromium browser and Blink web engine, which renders web pages and performs other core tasks, including navigation, running scripts, and security. Virtually all other web browsers – including Microsoft Edge – now use Blink rather than develop their own proprietary engines.

While Apple continues to plow its own furrow with WebKit, the only other standout is Mozilla's Gecko engine, used to power its Firefox browser. Unlike virtually any other browser comparison, then, we're not simply splitting hairs between two browsers who share large portions of code from the open-source Chromium browser project; we're genuinely comparing apples and pears.

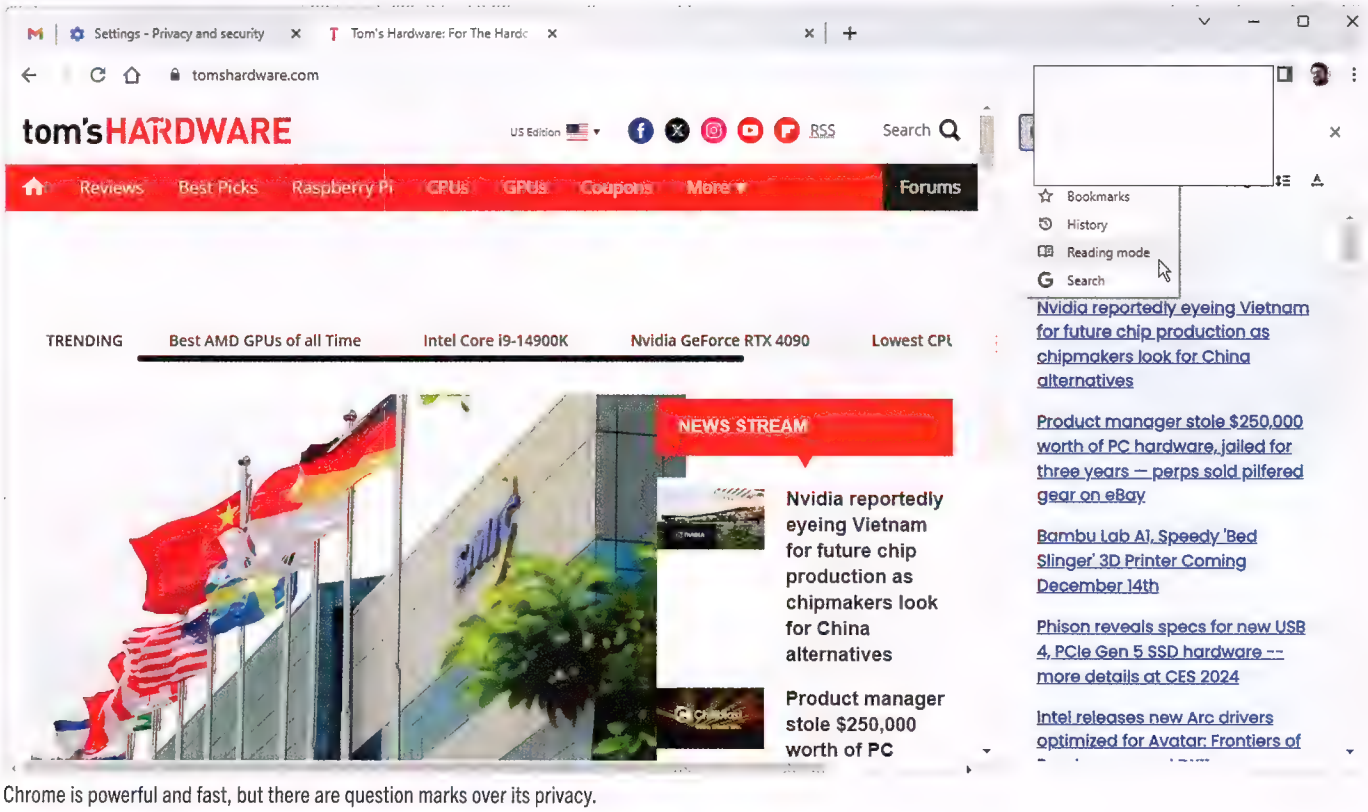
Any comparison, then, must start with Blink and Gecko. For the most part they work in a practically identical manner, so when you open a website in either browser, you see no difference. Behind the scenes, however, there are many differences – in the past, websites often produced multiple versions of a web page, each one optimised for a different browser or web engine.

Those days are long gone, and one reason why so many browsers have switched to Blink is because most sites focus solely on producing pages that work with it. Gecko does its best to keep up, but there are some pages that won't load properly (if at all) – however, Firefox users can simply try the pages in Edge without having to go near Chrome at all, although it's obviously still a faff.

Chrome also wins hands down when it comes to raw performance, outpacing Firefox by an average of around 40 percent in our tests using the three benchmarks at Browserbench.org. This translates to faster loading times and a snappier experience overall, but in the real world this is small beer – Firefox is perfectly responsive and fast enough in everyday use.

It's at this point that Chrome starts to lose its luster, thanks in no small part to Google's own practises around security and privacy. For example, the behemoth has long threatened to remove the functionality that allows ad-blockers to fully block ads on web pages, and it looks like this may finally come to pass this year. Google has also been rolling out plans to kill off tracking cookies, but this isn't an act of altruism; it plans to use its own tracking mechanisms instead. This should not be surprising for a company that dominates the web advertising and user profiling sphere.

In stark contrast, Mozilla stands firmly in the court of online privacy, as evidenced by its own Enhanced Tracking Protection tools, which have evolved over time to offer a wide range of options for blocking unwanted


Settings - Privacy and security
Tom's Hardware: For The Hardc
tomshardware.com
tom's HARDWARE
US Edition
RSS
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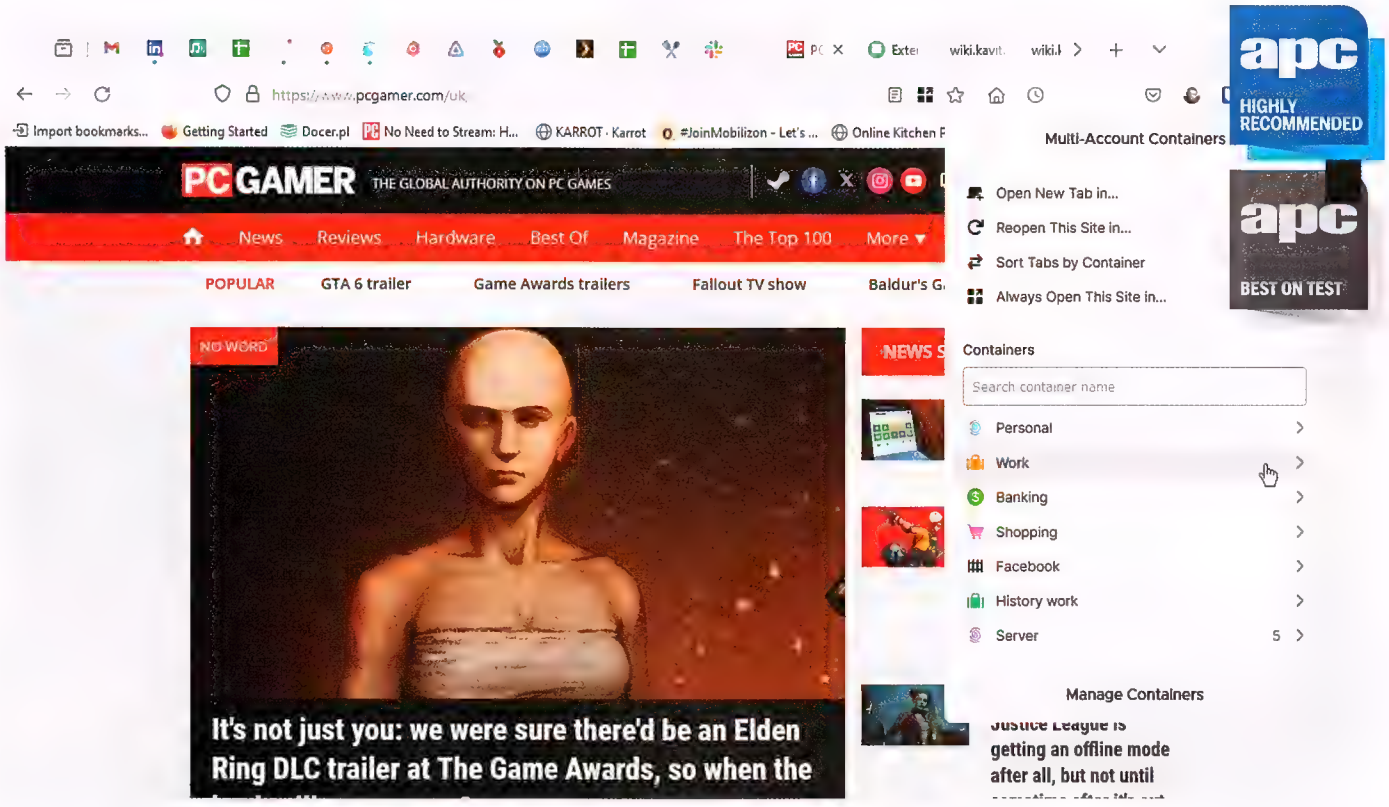
Reviews
Best Picks
Raspberry Pi
CPUs
GPUs
Coupons
More
Forums
TRENDING
Best AMD GPUs of all Time
Intel Core i9-14900K
Nvidia GeForce RTX 4090
Lowest CPU
NEWS STREAM
Nvidia reportedly eyeing Vietnam for future chip production as chipmakers look for China alternatives
Product manager stole $250,000 worth of PC
Bookmarks
History
Reading mode
Search
Nvidia reportedly eyeing Vietnam for future chip production as chipmakers look for China alternatives
Product manager stole $250,000 worth of PC hardware, jailed for three years — perps sold pilfered gear on eBay
Bambu Lab A1, Speedy 'Bed Slinger' 3D Printer Coming December 14th
Phison reveals specs for new USB 4, PCIe Gen 5 SSD hardware -- more details at CES 2024
Intel releases new Arc drivers optimized for Avatar: Frontiers of

Chrome is powerful and fast, but there are question marks over its privacy.



Firefox is one of the last major standouts against Chromium's complete domination.

trackers. A recent addition is Total Cookie Protection, which prevents cookies from being able to follow you from site to site. Users can also experiment with even more restrictive settings at the risk of breaking some sites' functionality (you can then whitelist those sites or take the hint to steer clear).

The browser experience

Moving away from the underlying engine to the browsers themselves, both Chrome and Firefox offer a similar subset of core features. Both pioneered tabbed browsing and allow you to sign into an account (your master Google account in Chrome, a dedicated Mozilla account in Firefox) to sync settings, passwords, add-ons, and tabs across all your devices – including mobile. Both feature well-stocked add-on stores for increasing the browser's functionality beyond the basics too.

Chrome scores additional points for natively supporting multiple profiles, which you could use on a solely personal level – for example, to separate work and home life – or to share the browser with multiple users on a single PC. There's even a 'Guest' option for temporary access, ensuring your settings, tabs, and bookmarks remain private.

While not present in Firefox natively, you can gain this per-user sharing experience with the Profile Switcher for Firefox add-on. However, Mozilla also offers its own official Multi-Account Containers add-on, which allows you to separate various parts of your life into individually colour-coded containers. Each container houses its own tabs and login details (so you can log into the same service with different accounts), plus each container is sandboxed from the others, allowing you to contain trackers within each silo. You can even integrate your containers into Mozilla's paid-for VPN or your own proxy setup for both security and geographical reasons (you could, for example, have one container sited at home, and the other for abroad, giving you access to local sites and currencies).

It's worth pointing out that neither Chrome's native features nor Firefox's add-ons can hold a torch to Vivaldi's Workspaces/Tab Stacks feature for bringing order to dozens of chaotic tabs.

As you'd expect from two venerable browsers that share a similar feature set, there's also little to choose between them on the user interface front. Chrome feels sleeker and simpler—the side panel providing one-click access to history, bookmarks, synced tabs, and so on is a nice touch, while Firefox offers one-click access to your history (and tabs) only.

One honorable mention should go to Firefox's integration with Pocket, which stems back to Mozilla's partnership with (and then acquisition of) Pocket. The free account lets you save a simple list of content to return to later, while Premium adds a permanent library, full-text search and unlimited highlights, among other things. It's a good feature that outclasses Chrome's simple Reading List option, but given you can add Pocket to Chrome via an extension, it's not the killer feature it might otherwise be.

Long story short, there's very little to differentiate the two when it comes to features and user experience. This leaves you choosing between performance – Chrome wins comfortably – or privacy and the open-source ethos, and here, of course, Firefox is the victor. You might be tempted to try a more privacy focused Chromium browser like Vivaldi or Brave to bypass Google, but striking a blow for open web standards in 2024 means rejecting Chromium altogether, and that means choosing Firefox. ■

VERDICT

★★★½☆

Google Chrome The closest thing to a standard browser, fast and compatible. Tied into Google's ecosystems, but just so-so privacy tools.

★★★★☆

Mozilla Firefox More user-focused privacy controls; completely open source; configurable. Not 100 percent compatible with some sites and not as fast as Chrome.

GADGETS

The gear we're lusting after

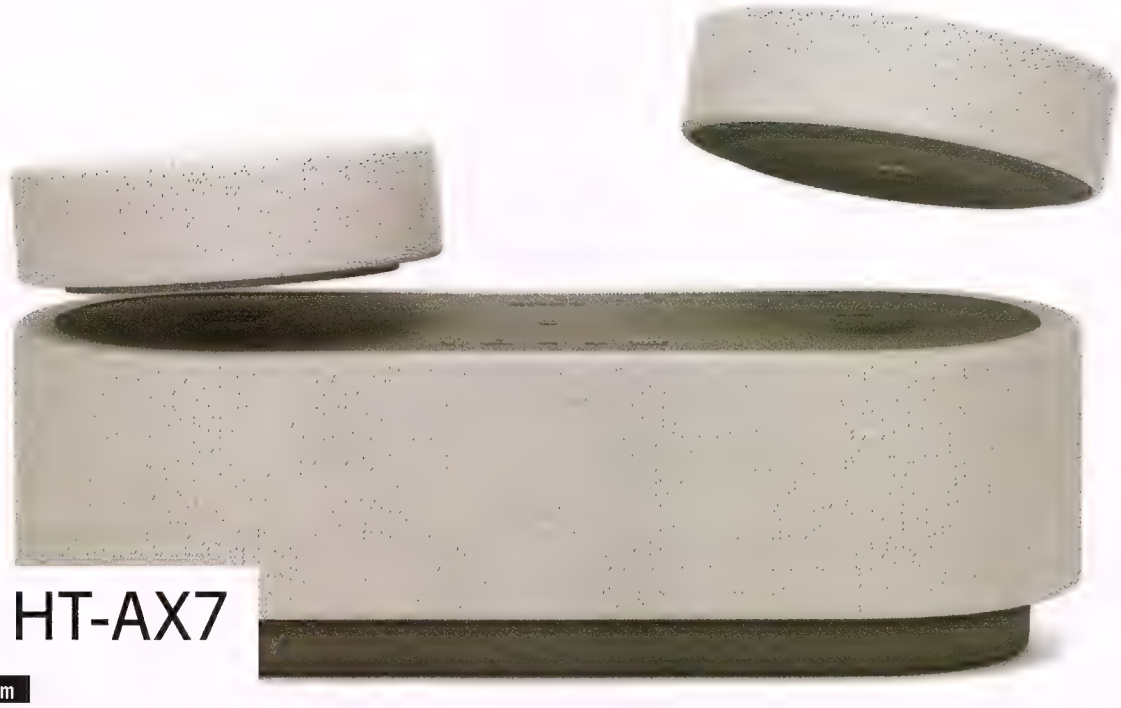
Loewe radio.frequency

~$380 | int.loewe.tv

Marking the 100th anniversary of Radio Frequenz (the company started by the Loewe brothers in Berlin in 1923), Loewe has brought out this celebratory 'smart radio'. With a few nods to the company's original Loewe OE33, the radio is made beautifully made with Canadian oak inlays – so each one is unique – and basalt-coloured acoustic fabric. There's also plenty of good tech on offer with DAB+, Bluetooth 5.0 and USB-C charging. You also get an easy-to-read, monochrome 2.6in high-contrast LCD display, and up to 14 hours of playtime. Despite its size (21.1x13.2x6.8cm) and portablility, the radio packs two full-range speakers for an impressively wide stereo soundstage and a bass radiator for some gutsy audio, as well as 28W of power.

If you're a fan of the company, this speaker is a nice, affordable investment.

The radio combines modern tech with classic looks.



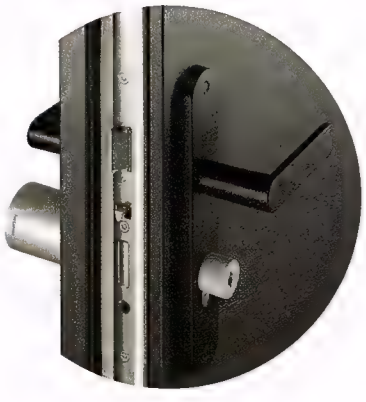
Sony HT-AX7

$TBC | sony.com

Sony's Portable Theatre System eschews the standard single-speaker soundbar format in favour of a central main unit and two satellites that can be detached from or attached to the main unit using magnets.

Built-in Bluetooth makes it easy to connect the HT-AX7 to audio sources like your Mac or iPhone and easily switch between them. Bluetooth also supplies the connection between the main unit and the satellites – no cables required.

The really clever bit, though, is Sony's 360 Spatial Sound Mapping, which enables the HT-AX7 to deliver immersive 3D sound. Plus, the whole thing comes with a built-in battery offering up to 30 hours of power between recharges.



NETATMO SMART DOOR LOCK

$TBC | netatmo.com

Netatmo is a leader in smart home tech, and the company has now brought out a smart door lock. Available now in the EU and expected to launch in other countries soon soon, the Lock features a high-strength stainless steel cylinder, reinforced with an anti-drilling plate and three security pins. Its smart key is inserted like a normal key, but it can also be locked or unlocked with your iPhone too – thanks to a built-in NFC connection. It's also easy to deactivate the keys if you lose them, and the Lock is compatible with Apple Home.

MOPHIE 3-IN-1 EXTENDABLE STAND

$249 | jbhifi.com.au

This 3-in-1 extendable stand with MagSafe (MFi certified) delivers up to 15W of power to your iPhone, Apple Watch and AirPods. The MagSafe charging stand extends to save space on your desk. Being able to extend the height – from 19cm to just over 40cm – and adjust the head is particularly useful for charging your phone while on a video call. You can have your iPhone in portrait or landscape mode, and the base is made from weighted steel so it feels stable and secure, even when your phone is in a raised position.

LEICA SOFORT 2

$649 | leica-camera.com

The Sofort 2 combines the best of both instant print and digital worlds. You can shoot instantly to the Instax Mini format (Sofort translates to immediately, fact fans!) or save images digitally to the camera's internal memory or SD card. The camera only measures 123x87x44mm but features a 28mm-equivalent lens with an f/2 to f/16 aperture range, and there are 10 Filmstyles and 10 Lensstyle options for various filters and effects. When used in combination with the Sofort app, images can easily be transferred to iPhone, and you can even remotely control the camera.

REVIEWS

Expert reviews and recommendations to help you buy with confidence

THIS ISSUE

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APC is Australia's oldest consumer technology magazine – having been consistently in print for over forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

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Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

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APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

APC TESTBED **THE CURRENT APC TESTBED USED IN THE LABS FOR BENCHMARKING ALL COMPONENTS. THIS TESTBED IS UPDATED AS NEW AND RELEVANT TECHNOLOGY COMES ON STREAM.**

CPU Intel Core i9 12900K **Motherboard** Asus Maximus Z690 Apex **Graphics Card** Nvidia GeForce RTX 4090 Founders Edition **RAM** 2x16GB G.Skill Trident Z5 DDR5-6000 **Power Supply** Corsair AX1000 **Storage** Seagate Firecuda 530 2TB **Case** Thermaltake Core P8 **Cooling** Cooler Master Flux PL360 AIO **Operating system** Windows 11 Pro 22H2

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When a product scores 4.5 out of 5, it carries the Editor's Choice Award. These are products that exceed expectations and deliver a quality experience up there with the very best.

APC HIGHLY RECOMMENDED
You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

PRICE $5,099 **WEB** microsoft.com/en-au

Microsoft Surface Laptop Studio 2

The Surface Laptop Studio 2 is a decent upgrade to the unique 2-in-1, but is Microsoft charging too much for it?

Microsoft's scissor-like hinge design on the Surface Laptop Studio screen was a big hit when it launched, and now close to two years on there's still no solid competition against it. Unfortunately, Microsoft is charging a pretty hefty premium for the Surface Laptop Studio 2, since this highly desirable tech costs hundreds – or even thousands – more than similar offerings.

The unique touch capabilities pair nicely with the more powerful Intel 13th Gen and Nvidia 40 series components to ensure there's no hardware limitations to your creativity. The sweet spot for the Surface Laptop Studio 2 is the Nvidia RTX 4050 GPU model, since it has the highest combined performance per dollar out of the range. If you can get one of the 4050 units on sale (we've seen them go for $3,299) then it gets close to a competitive price point, but even on sale the integrated GPU and 4060 models are expensive for what you're getting.

The Surface Laptop Studio 2 is almost identical to its predecessor in terms of overall design. It's not exactly the same chassis, adding a fraction of depth, thickness and weight to the overall design to fit the more powerful processors. It's hardly noticeable however, and has the added benefit of allowing the device to include a USB Type-A socket and microSD Card reader to the list of interface options; a handy inclusion for anyone.

The hero here is still the screen. Microsoft is using the same 14.4-inch PixelSense Flow display at a 2400 x 1600 pixel resolution that it used on earlier devices. So, you'll get the same 120Hz refresh rate and optimised touchscreen capabilities. Microsoft has done a bit more when it comes to colour, calibrating machines individually, offering VESA DisplayHDR 400 and including vivid colour presets that can run HDR content. Unfortunately, it's still not a new screen, so there's no capacity for offering enhanced colour workspaces for anyone needing to edit in DCI-P3 or Adobe RGB.

In addition to being able to tackle entry-level 1080p gaming and heavier graphical workloads, the device is also equipped with a dedicated AI processor that speeds up Microsoft Copilot operations and adds advanced functionality to web conferencing. The Dolby Atmos speakers combine with the 2400 by 1600 pixel display to make media and work tasks look great. This combines with the 120Hz refresh rate to make games and graphical applications super smooth.

Battery life is reasonable for a Windows 11 creative workstation, lasting six hours and 37 minutes in light work tasks. So all-up a lot is similar to the original here, but the updated CPU is two generations ahead of its predecessor and can provide up to 2.4 times the CPU performance in some benchmarks. Graphically it'll get 60-plus fps in modern 1080p games and it's a competent creative workstation.

BENCHMARK RESULTS	Microsoft Surface Laptop Studio 2	Microsoft Surface Studio Laptop
PCMark 10 - Overall (score)	5,480	5,036
Cinebench R23 - CPU (multi-threaded)	10,886	5,036
3DMark Time Spy (score)	8,283	4,432
F1 2021 - 1080p, Ultra (fps)	68	49
Battery life - 1080p video playback (h:min)	07:38	06:04
Peak CPU temperature (ºC)	80	91
CrystalDiskMark Read (MB/s)	6,189	3,517
CrystalDiskMark Write (MB/s)	4,945	2,979

SPECS W11 Home; 14.4-inch PixelSense Flow display at 2400 x 1600 pixel resolution, 120Hz, VESA Display HDR400, DolbyVision; Nvidia GeForce RTX 4060 (80W) 64GB RAM; 1TB Samsung SSD; 58Wh (7h38min 1080p movie playback); 32.3 x 23 x 2.2cm; 1.98kg.

VERDICT

★★★★☆

A powerful creative ultrabook with great stylus compatibility that isn't afraid to charge more for its features.

Joel Burgess

PRICE $2,299 **WEB** alliedgamingpc.com.au

Allied Patriot-A

A powerful gaming PC with the right stuff.

Allied is an Australian-based PC manufacturer that clearly puts a lot of thought into what goes into its PCs. Like the Allied Stinger-A we reviewed previously, the Allied Patriot-A comes with a powerful graphics card.

The RTX 4070 of the Patriot-A is more than capable of holding its own at 2560 x 1440, but a strong graphics card is just one part of what makes up the Patriot-A. Its other components provide a good balance, and its classy aesthetic, accessories and Australia-based support team combine with one another to make up an impressive overall package.

The Patriot-A is available directly from Allied's Australian webstore. It's priced at $2,299. That's very good value for an RTX 4070-based PC.

Upon firing it up for the first time, it becomes clear that the Patriot-A is a well built and attractive gaming PC with clean cable management and attention to detail. It's a compact white themed rig featuring white cable sleeving. If you're a fan of RGB, you'll love the Patriot-A. It includes seven RGB fans and RGB memory too.

The included RTX 4070 graphics card is the star of the build. Considering it costs nearly $1,000 to buy one separately, it's a very smart choice for a build in this price range. It's partnered up with AMD's six core Ryzen 5 7500F. It's AMD's entry level 7000-series Zen 4 CPU, but don't let that worry you. It can boost up to 5.0 GHz and it's not a bottleneck for gaming. If you plan to do lots of productivity type tasks, Allied gives you the option of selecting a higher core count processor.

If there's anywhere Allied held back a little, it's the RAM and power supply. 16GB of DDR5-5200 is nothing to rave about. The inclusion of 6000MHz RAM would add a little bit of extra performance in some apps and games. The 650W PSU is best described as adequate. It's perfectly fine for this spec, but a little bit of overheard for a future upgrade would be good.

It's a classy build with a capable spec, but how does it perform? Pretty damn well, all things said. The Patriot-A's RTX 4070 will easily dispatch systems with RTX 4060 class cards, while the 7500F, being based on AMD's current Zen 4 architecture, should stand up well against older generation hex-core processors.

The Patriot-A is another Allied system with a spec that's built for gaming first and foremost. We've seen other examples around this price with silly things like 360mm AIOs, 32GB of DDR4 or a fast CPU – but with a lesser graphics card. Systems like that might look good on paper, but they'll come up short unless they also include an RTX 4070 class graphics card. The Patriot-A gets the balance right. A gamer on the lookout for a gaming system in the $2,000 to $3,000 range should absolutely consider the Patriot-A. But it's not all about a classy and high performing system. Allied has a well established history, the systems are built locally and you get Australian based after sale support.

BENCHMARK RESULTS	ThermalTake Citadel V2	Allied Stinger-A	Allied Patriot-A
PCMark 10 - Overall (score)	7,198	9,662	11,214
Geekbench 5 - Multi-core (score)	8,437	8,028	10,194
Max CPU Temp (C)	71	73	77
Cinebench R23 - multi-threaded CPU	11,670	11,107	14,590
3DMark Time Spy (score)	10,220	12,067	15,300
Sid Meier's: Civilization VI - 1080p Ultra (fps avg.)	192	233	
CrystalDiskMark Read (MB/s)	3,659	3,713	3,709
CrystalDiskMark Write (MB/s)	2,845	2,520	2,495

SPECS CPU AMD Ryzen 5 7500F; **COOLING** Allied Sidewinder ARGB 120mm Air Cooler; **MOTHERBOARD CHIPSET** B650; **MEMORY** 16GB (2x 8GB) DDR5-5200; **GRAPHICS** GeForce RTX 4070 12GB; **STORAGE** 1TB NVMe SSD; **POWER** 650W; **WARRANTY** 2 years RTB

VERDICT

★★★★☆

Excellent RTX 4070 performance, build quality and attention to detail, Australian made and supported.

Chris Szewczyk

PRICE From $1,599 **WEB** store.acer.com

Acer Nitro 5

The budget gaming laptop king returns with another explosive device for those on a shoe-string.

The Acer Nitro 5 has been one of our best budget laptops for a few years now, and with not that many updates on the latest generation it's still a top contender for gamers on a tight budget. As a budget model, we can forgive the fact that this unit is still running a 12th generation CPU, especially since many of Intel's lower end 13th gen processors offered similar performance this year anyway.

The one area that has been updated is the GPU which now includes either a 4050 or 4060 from Nvidia. Acer sent us the latter to test out, an update that improved gaming performance by about 20% over the previous 3060 models. This is a noticeable jump of between 10 and 40 frames per second meaning you can play less demanding games at well over 120fps and modern shooters like *Cyberpunk 2077* at over 80 fps using 1080p Ultra settings.

This matches up nicely with the 144Hz refresh rate on the 15.6-inch FullHD IPS screen, allowing you to really push games to the maximum potential without either component overpowering the other. While the screen is fine for FullHD gaming, against brighter QD or OLED displays the budget IPS panel Acer is recycling is starting to look a little dull and washed out. Still, it's got a 300 nit typical brightness and 72%NTSC (100% sRGB), so it's perfectly reasonable for those looking to save as much as possible.

The model we tested came with a 12th gen Intel i7, but at the time of writing Acer only had models with the i5-12450H CPU, 16GB of RAM a 521GB SSD and the 4060 GPU. This isn't a bad configuration as most games will have little to no perceived impact, but it will have general computing performance up to 40% behind what our test model achieved. Acer was selling this configuration for $1,399 down from an RRP of $2,199. This price is pretty impressive and we only found a couple of comparable options even close to this sale price, which means it'll be difficult to beat in the budget category again.

The Nitro 5 offers Wi-Fi 6 connectivity and a gigabit Ethernet port to ensure you have a solid network connection for online titles, but it's not the latest Wi-Fi 6E that you'd expect on more expensive gaming laptops. It's also got a Thunderbolt 4 Port and an HDMI so you have options for connecting to an external display and the screen has a better than average range of motion so you can fold it back far enough to use it on your lap.

There's three USB 3.1 Type-A ports and a 3.5mm headphone jack to ensure you can connect all your peripherals. The included NitroSense app makes it easy to control your fan settings for more stable gaming and while the device can get a little loud with the fans running full-tilt, it does a good job of removing heat from the system. The SSD is also as fast as you could want, reaching read and write speeds of 6,589 MB/s and 3,816 MB/s respectively and while the five hour 13 minute work battery life isn't amazing, it's not bad for a gaming device.

BENCHMARK RESULTS	Acer Nitro 5 (2023)	Acer Nitro 5 (2022)
PCMark 10 - Overall (score)	6,668	6,836
Max CPU Temperature (C)	100	97
1080p movie playback (HH:MM)	04:07	03:02
Cinebench R23 - CPU (Score)	14,290	11,557
3DMark Time Spy (score)	10,007	8,351
RDR2 - 1080p Ultra (fps Av.)	74	63.3
CrystalDiskMark Read (MB/s)	6,589	6,922
CrystalDiskMark Write (MB/s)	3,816	4,501

SPECS W11 Home; 15.6-inch IPS display at 1920 x 1080 pixel resolution, 144Hz, 300nit (Typ. brightness), 72%NTSC; Intel Core i7-12650H CPU; Nvidia GeForce RTX 4060 GPU (140W); 16GB RAM; 512GB PCIe SSD; 57Wh battery (4h 7 min 1080p movie playback); 36 x 27.1 x 2.7cm; 2.5kg.

VERDICT

★★★★½

A well rounded budget laptop at an unbeatable price.

Joel Burgess

PRICE $2,699 **WEB** rog.asus.com/au

Asus ROG SWIFT OLED PG49WCD

Has Asus made the best monitor ever?

We've seen a few massive monitors in our time, but when the coffin-like box for the Asus ROG SWIFT OLED PG49WCD gaming monitor turned up, we weren't sure whether to usher our younglings away from the potential crush hazard or throw a bone in the air to mark the occasion.

Despite the size, set-up did not amount to manhandling an albatross: you finger-screw the feet into the stem, clip the stand's quick-release catch into the screen and it's ready. Asus provides a bracket if you want to use a (robust) monitor arm instead.

The screen's key specs tell a story on their own: it's got a curved (1800R), 49-inch diagonal, 'SuperWide' 32:9 ratio(!), 144Hz, 1000-nit peak brightness, HDR, UHD, 5,120 x 1,440, QD-OLED panel. The latter is an OLED evolution with brighter image and better viewing angles thanks to Quantum Dot technology, its blue-subpixel backlighting and fewer brightness-sapping layers. Asus says it's actually a second-gen QD-OLED panel which uses an enhanced, more-efficient, blue-light source for extra definition and a graphene cooling layer to reduce burn-in potential.

A colourful Windows Desktop looks spectacular on it with text being rendered slightly more clearly than first-gen QD-OLED screens. Massive spreadsheets were well-rendered too.

Its similarity to a racing car's windscreen meant we started with *PCars*, *Forza* and *CyberPunk 2077* and immediately felt highly immersed thanks to the long, unbroken screen filling our peripheral vision with bright, vibrant, high-contrast, realistic, life-sized imagery. However, we felt a bit motion-sick when coming down Mount Panorama (doing this in VR doesn't bother us).

Playing adventure shooters like *BorderLands* is a blast, as anything on a black background practically popped out of the screen. *Far Cry* in HDR looked incredible thanks to very-bright light sources and extra details being revealed in shadows and highlights. Nvidia's G-Sync avoids image tearing while the 144Hz refresh rate (and fast pixel response time) keeps fast-moving objects just sharp enough for competitive shooters.

Some games' menus can't handle the obscene resolution: they remain functional but look odd. However, our main gripe was that you often need to significantly turn your head to see in-game info like ammo, health and your inventory.

Other potential issues include the glossy coating's black-mirror reflectivity when viewing dark content and/or having a bright light source behind us. Also, the 1,440-line vertical resolution can feel restrictive when performing high-res graphical work.

Connectivity is generous (but tricky to access) and includes HDMI 2.1, DisplayPort 1.4, USB-C (with DP) and USB-B (cables are all included). A four-port, USB-A hub operates as a KVM switch for connecting multiple computers while keeping the same peripherals.

A mini joystick-button makes navigating the OSD quick and intuitive. Atypical features include ROG's onscreen crosshairs – normal and zoomed-in, sniper mode – Shadow Mode for killing contrast in favour of revealing sneaky enemies in shadows and highlights; Picture in Picture; and Asus' Aura RGB lighting.

At $2,699 it's not cheap, but it's exquisite. If you don't mind reflections or turning your neck a lot, it should be top of your list.

SPECS 49-inch, glossy, 5,120 x 1,440, HDR, G-Sync, 144Hz, curved (1,800R) QD-OLED. 0.03ms GTG response time. 250-nit brightness. 1,500,000:1 contrast. 1x DisplayPort 1.4, 1x HDMI 2.1, 1x USB-C. 2x USB-A 3.2, 1x USB-B, 2x USB-A 2.0, headphone jack, SPDIF out. Tilt +20° -5°, Swivel +20° -5°, Height +100mm. 1196 x 372 x 155mm, 11.7KG.

VERDICT

★★★★★

Arguably the most desirable monitor ever made. But, there are some caveats.

Nick Ross

PRICE $1,699 **WEB** asus.com

Asus ROG Swift Pro PG248QP

Asus' TN based quick draw monitor is the fastest pro gaming screen in town.

The Swift Pro PG248QP is the fastest professional e-sports screen that you can buy. For any budding pro gamers that fact alone is likely to get you over the line, but the overclocked 540Hz display isn't just considerably faster than the previous title holder: the 500Hz Alienware AW2524H display... it also comes with a number of additional technologies that'll help ensure you have the edge when it comes to quick-response competitive gaming.

One of the more interesting technologies featured here is Nvidia's Reflex Analyser, which allows you to test your current system's responsiveness from PC to screen. For those that have one of the compatible mice from Asus, Logitech or Razer then you'll also be able to get full system latency measurements from peripherals to what you see on screen. This is indispensable tech for anyone making money from how fast they click, but it's probably going to be overkill for the rest of the gaming lemmings out there.

There's also a G-Sync processor that offers optimised tearing and stuttering without adding input lag and Nvidia's Ultra-Low Motion Blur 2 tech adds extra clarity to small objects moving quickly, something that's been refined to appeal directly to high performance gamers.

The fast and full featured display uses a 24.1-inch TN panel in a 1920 x 1080p resolution, which is still the standard format for competitive e-sports gaming. You do get slightly above average 125% sRGB colour reproduction capabilities and a good 400 nit typical brightness, but don't expect this TN panel to look particularly good. The poor viewing angle, low resolution and accurate but conservative colour means it's strictly for competitive gaming and doesn't have time for frivolities like looking at colourful vistas or watching videos. The upside of this is that you're likely to practise your gaming even more since it won't be particularly enticing to do anything else on it.

The base has clever adjustable feet to allow stability in confined spaces, without losing the ability to stretch out for maximum balance. The Swift Pro PG248QP uses the ESS codec and PCM audio support for very low latency surround sound that will be essential in any competitive games that require you to use your ears.

It's got a DisplayPort 1.4 and two HDMI 2.0 ports in case you'll have a few devices connecting to it, but only the DP will be capable of anything over 240Hz. It's also got a couple of USB A sockets for attaching a mouse and keyboard to reduce latency. You'll need to use the headphone jack as there's no speakers on this rig, which makes sense considering that any serious gamer will have gaming headphones.

If you're after the fastest gaming performance, no matter the required sacrifices, and you're willing to pay $1,699 for it then this is the display for you... but for most there's too many downsides for this level of gaming display to be truly appealing.

"The poor viewing angle, low resolution and accurate but conservative colour means it's strictly for competitive gaming and doesn't have time for frivolities like looking at colourful vistas or watching videos."

SPECS 24.1-inch E-TN display at 1920 x 1080 pixel resolution; 540Hz refresh rate, 0.2ms response time; 400nit (Typ. brightness); G-Sync processor; HDR10; 1 x DP 1.4, 2 x HDMI 2.0; 55.7 x 50.2 x 25.5cm; 7.5kg.

VERDICT

★★★★½

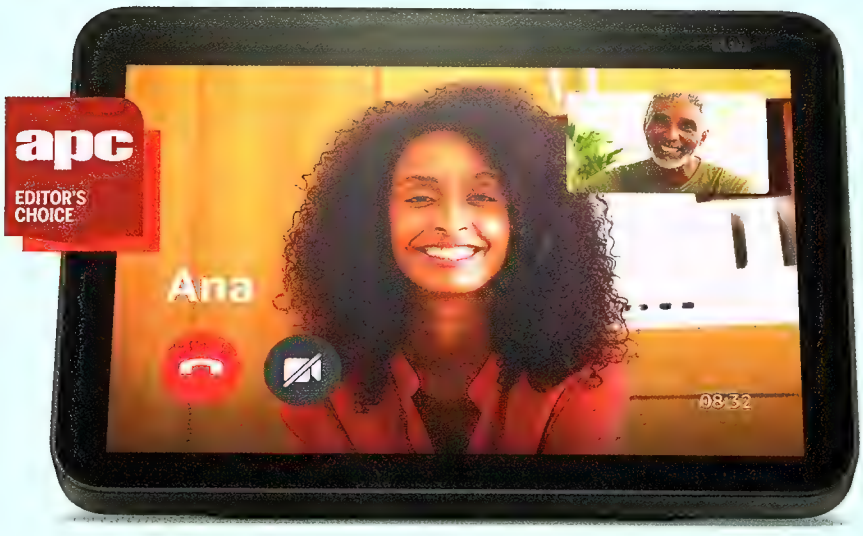
A performance focused gaming machine made exclusively for professional gamers.

Joel Burgess

PRICE $230 **WEB** amazon.com.au

Amazon Echo Show 8 (3rd gen)

A huge upgrade, with better audio, faster performance and added smart home support.



The third-generation Amazon Echo Show 8 looks a lot like the 2021 model, but it brings a tonne of improvements that make it the best Echo Show yet – and arguably the best Echo device, full stop.

When I say it looks like the previous version, that's not exactly a compliment. The 8in 1280 x 800 display remains crisp and clean, with excellent brightness, but the thick bezels are starting to feel dated. Still, the front now has sleek edge-to-edge glass, and the sides and rear have been slimmed down, too. It feels robust, and is made from 29% recycled materials – so it's not as green as, say, Apple's latest devices, but it's getting there.

Another change is that the camera has been moved from the right side of the frame to the centre, which works better for video calls. It uses the same 13MP sensor as the previous model; despite this high resolution, images don't look particularly crisp, but it's fine for informal video calls or security footage. As before, the auto-framing feature pans and zooms to keep you centred in the frame, based on your proximity and position. I'm impressed by how well this works, although if you're moving about while talking it can be a tad slow to follow. For those who are uncomfortable about having a camera inside their home, the physical camera shutter is still there, along with soft buttons to disable the microphone and adjust the volume.

Then again, if you keep the camera active, you can take advantage of a new feature called Visual ID. This lets the Show learn what you look like, then personalise its responses and the information displayed on the screen, based on who's standing in front of it. It's as if each member of your household has their own personal assistant. I also like the new Adaptive Content feature, which adjusts the display according to how far away you are from the device (so, detailed info when you're up close, more at-a-glance updates when you're more distant).

Perhaps the biggest upgrade to the Show 8 is a new eight-core SoC, which includes Amazon's AZ2 Neural Network Engine. Amazon claims this delivers a 40% speed improvement over its predecessor, and I can confirm that the Echo Show 8 is easily the fastest Show device I've used. The touchscreen felt beautifully responsive, and Alexa always responded promptly, whether I was asking her to turn on my smart lights, call a friend for a video chat or translate words and phrases into a foreign language. The Show even pulled up a movie from Amazon Prime Video within a couple of seconds – a task that could take my last-gen Echo Show 5 as long as a minute.

Another internal enhancement is to the audio system. Just like the second-generation Show 8, the new model has 2in neodymium stereo speakers with a passive bass radiator, but the hardware that drives them has been upgraded, now including support for spatial audio and acoustic room sensing, which tailors the sound to suit the environment. The effect is impressive, with clear highs and a solid bass response. I wouldn't call it an audiophile experience, but it's better than the massive soundbar I have in my living room, and it goes loud enough to comfortably accompany your next party.

A final upgrade is improved smart-home capabilities; as well as existing "Works with Alexa" devices, the Echo Show 8 can now manage Matter, Thread and Zigbee devices.

All of these enhancements have a big collective effect. Thanks to the improved speed, smarts and sound of the new Echo Show 8, I found myself much more eager to throw on a TV show while cooking in my kitchen, or to stick on Taylor Swift while doing the dishes. Video calls to friends and family feel less like a game of hide-and-seek, and it's good to know that I don't need to worry about controlling any future smart home devices I buy.

The only thing that holds back the Echo Show 8 is its price. If you want units for the kitchen, bedroom and living room, it gets expensive quickly. Then again, Amazon does offer frequent discounts on its own-brand devices.

With its generous screen and excellent audio, however, I think the new Show 8 is worth the asking price. It's a slick, well-made device that goes far beyond the capabilities of a conventional smart speaker.

SPECS 8-core SoC with Amazon AZ2 neural network engine; 8in 1,280 x 800 touchscreen; dual 2in stereo speakers; 4-microphone array; 13MP camera; Wi-Fi 5; Bluetooth (A2DP and AVRCP); Matter, Thread and Zigbee support; 200 x 106 x 139mm (WDH); 1kg; 1yr limited warranty.

VERDICT

★★★★★

A class-leading smart speaker with many powerful features.

Michelle Rae Uy

PRICE $170 - $320 **WEB** corsair.com

Corsair iCue Link Ecosystem

Single cable daisy-chaining luxury.

This is going to be a touch different to some of our usual reviews, as we're actually going to be evaluating a number of products from Corsair, all under one review. Yes, we're talking about Corsair's iCue Link PC building ecosystem.

iCue Link is a complex daisy-chaining solution designed to simplify the build process, while providing a tonne of customisation and top-tier build features across Corsair's new product stacks. It's early days, but the company has launched a number of products, including a range of AIOs, both with and without screens, in a multitude of different sizes, fans of course (in black and white at 140mm and 120mm variants, each with its own temperature thermistor baked in), an armada of different cable types and accessories, to get to all those hard to reach places, and more impressively, a whole array of liquid-cooling componentry, as well including everything from pump/res combos with integrated displays, to full GPU blocks and hybrid fan solutions.

It's an impressive number of products for sure, but they all come with one small caveat: the price, and boy these things aren't cheap. A quick look on Amazon, and you'll find a standard starter-kit including three 120mm fans, will set you back $170 straight out of the gate. Want a 240mm AIO to pair with that? No screen? That's another $250 on top. LCD screen version of that instead? $320. Admittedly, you do get everything you need to go with that, but it's a tough pill to swallow.

There's definitely some dev cost in there. Corsair has developed its own proprietary (sigh) heavy duty, reversible connector to interconnect these devices. Each product has a port for these, or a male-to-male adapter for them, and they lock magnetically to one another. This transfers both power and data, and is an impressively rugged bit of kit.

Building with the kits generally is smooth sailing. There is some thought needed about which cable goes where, and how many devices you have on each line (spoilers, you can only have seven devices on each side of the Link hub), but otherwise, it's a seamless process that does remove a lot of the faff involved with hooking up multiple fan and RGB headers at the end of the build process.

The big question: is that worth the cost? That's going to be a tricky one to answer. After all, most will typically build a system once, and as any hobbyist will tell you, it's fairly easy to do some simple cable management and have a real clean-looking system straight out of the gate.

There are some cool little features though, unsurprisingly in the RGB field. You can set up a 'time-warp' effect, where the LEDs will fire at just the right frequency to simulate a static fan, even when the blades are moving, which is pretty neat. And of course, there's all the iCue Murals custom RGB lighting and syncing. This means that it'll sync with your Philips Hue and Nanoleaf products as well, but that's about it.

All in all, it's a clever daisy-chaining system – one of the best we've seen, with a hefty price tag. The ultimate question will be just how far will Corsair take the platform? Will we see cheaper products eventually filter down the pipeline, or full integration with cases, memory, power supplies? There's some incredible opportunities here, but it needs to be handled just right.

SPECS Coolers: 240mm / 280mm / 360mm / 420mm; **Colorways:** Black / White; **Power Required:** 1x 6pin PCIe power; **Motherboard Connectivity:** 1x Internal USB Header, 1x CPU fan tachometer; **Maximum Number of Devices:** 14 per Link Hub, 7 per line.

VERDICT

Incredibly intuitive to build with, impressive light-shows, integrated temperature sensing on fans is very cool, but super pricey.

Zak Storey

PRICE 2-pack, US$1,149 (~$1,750) **WEB** amazon.com

Amazon Eero Max 7

The first Wi-Fi 7 mesh is here – but don't buy yet, as compatible client devices are still a way off.

New technology klaxon! The Eero Max 7 is the second mesh we've seen – TP Link's Wi-Fi 7 Mesh System BE85 was the first (APC 526, 5/5 stars) – that works with Wi-Fi 7, also known as 802.11be. Yes, that's right: it's barely two years since we were welcoming Wi-Fi 6E as the latest and greatest wireless standard, but its successor is already here.

And to be fair, this is real next-generation stuff. Wi-Fi 6E was basically the same standard as Wi-Fi 6, merely extended into a new wireless frequency range. Wi-Fi 7 is a more fundamental upgrade, with features including a new ultra-fast 320MHz channel width on the 6GHz band and 4K-QAM encoding that packs more bits per second into the carrier signal.

The most exciting enhancement is MLO, short for multi-link operation. All previous Wi-Fi standards have required devices to connect on a single radio band, but with MLO, Wi-Fi 7 devices can now communicate simultaneously across the 2.4GHz, 5GHz and 6GHz bands. Not only does this massively increase the bandwidth available to each client, it should also mean more reliable and stable networks – because even if one band is affected by interference or a partially blocked signal, the other two will be there to keep up the connection.

It costs how much?

As you might imagine, this cutting-edge technology comes with a considerable price tag. If you need to cover an area of 232m2 or less, you can use a single Eero as a standalone router for a mere US$599 (~$900); a twin-pack covers up to 464m2 for US$149 (~$225); while a three-unit bundle claims area coverage of up to 697m2 for a rather stiff US$1,699 (~$2,550). We're quoting US pricing in this review by the way, because Australian pricing is yet to be announced as we went to press, but we believe is imminent.

Faced with those prices, your first question is likely to be: is it really worth it? And the short answer is: not yet. For one thing, you almost certainly don't have a computer that's capable of taking advantage of Wi-Fi 7. A few manufacturers have announced high-end specialist laptops that support the new standard, but mainstream systems aren't expected to appear until well into 2024, and I won't be surprised if it's 2025 before the technology is widespread.

Well, you might be thinking, at least I can take advantage of Wi-Fi 7 on my phone, right? It's true that a number of handsets are already arriving with early-adopter support for Wi-Fi 7, including the OnePlus Open and Google's new Pixel 8 phones.

However, don't expect these compact, low-power devices to support the full speeds that Wi-Fi 7 is capable of. Using a Xiaomi 13T Pro smartphone, the fastest download speed I achieved over Wi-Fi 7 was 34MB/sec – slower than a typical Wi-Fi 6 link. If you want to see what Wi-Fi 7 is really capable of, you'll have to wait for more mature (and, most likely, more expensive client hardware.

Max 7 features

So, expectations thus managed, what can we say about the Eero Max 7 right now? It certainly feels like a heavyweight system. The upright stations are much larger and chunkier than previous Eero meshes; I found the new units ugly, especially with their high-gloss, white plastic casing, but they cram in a lot of technology, including 4x4 MIMO antennas on both the 5GHz and 6GHz bands. Round the back they offer the best Ethernet provision I've seen on any mesh: each station offers a pair of 2.5GbE ports and a pair of 10GbE ports, and they're all auto-sensing, so you can choose which port to use for your internet line and which to save for local devices.

The software has distinctive features, too, though they won't be at all surprising if you've used an earlier Eero system. The whole mesh is controlled from the Eero smartphone app – there's no browser interface – which lets you monitor your network, check which clients are connected to which stations, and perform basic administrative tasks such as adjusting Wi-Fi security settings and managing the guest network.

The Eero also ties into Amazon's existing home ecosystem. If you have a compatible Echo device then you can set that up as the Wi-Fi extender, and if you buy compatible IoT gadgets you can use Amazon's Frustration-Free Setup system to get them online without any interaction.

For subscribers only…

Annoyingly, though, the real headline features require a paid "Eero Plus" subscription. Costing $159 per year, this does include some things you'd expect to pay money for: there's a VPN service provided by Guardian (**guardianapp.com**) with servers in 17 countries, network antivirus powered by Malwarebytes, and a family subscription to 1Password (**1password.com**) bundled in with the deal. Parental control features are included. At the same time, it's galling to see more basic stuff such as Wi-Fi analytics, dynamic DNS and internet failover also rolled into Eero Plus. It doesn't cost Amazon a cent to provide these services, so it's a liberty to lock them behind a costly subscription – especially after you've paid so much for the mesh itself.

SPECS Tri-band 2.4GHz/5GHz/6GHz Wi-Fi 7 mesh; 10 x spatial streams; 2 x 10GbE; 2 x 2.5GbE; quad-core A73 processor; 184 x 90 x 222mm (WDH); 45W external USB-C power supply; 1yr limited warranty.

FAR LEFT The Eero app lets you monitor your network and perform basic admin tasks. **LEFT** Basics such as Wi-Fi analytics and dynamic DNS have to be paid for separately.

Turn of speed

While the main point of the Eero Max 7 is obviously its Wi-Fi 7 support, it will work perfectly well as a mesh system for your Wi-Fi 6 clients (and indeed older ones). Performance with legacy devices isn't bad at all: I tested this in my usual way, setting up a two-station mesh in my own home, then carting a laptop around the house, copying files to and from an Asustor AS3304T NAS attached to one of those multi-gigabit Ethernet ports and measuring upload and download speeds.

The tables show the results I obtained, along with a selection of other mesh systems we've recently reviewed for comparison – two Wi-Fi 6 meshes, namely the Asus ZenWiFi XD5 and Mercusys Halo H80X, plus three 6E-capable systems from Linksys, Netgear and TP-Link.

The Eero Max 7 raced well ahead of the Wi-Fi 6 meshes, however, it couldn't quite match the performance of any of our Wi-Fi 6E systems. One factor here might be that, frustratingly, I couldn't get the Eero to use Wi-Fi 6E at all: every time my laptop tried to connect on the 6GHz radio band, the Eero quickly switched it over to a regular Wi-Fi 6 connection. I suspect this happens because the Eero system doesn't have a dedicated backhaul radio, and is therefore trying to keep the 6GHz range clear for mesh traffic travelling back and forth between stations. There's unfortunately nothing you can do about it, as the Eero app doesn't give you any control over band splitting or steering.

The best is yet to come

Once I'm able to pair the Eero Max 7 with proper Wi-Fi 7-capable devices I expect to see transfer speeds beyond anything Wi-Fi 6E gear can deliver. But just how fast that will be is unclear: Amazon hasn't shared the full details of the Eero's radio capabilities, merely promising wireless connections at "up to 4.3Gbits/sec". That suggests it won't get close to realising the full potential of Wi-Fi 7, which in theory could go as high as 46Gbits/sec. For comparison, the Netgear 970 mesh, expected to reach these shores in early 2024, claims top speeds of 5.8Gbits/sec on the 5GHz band, plus 11.5Gbits/sec on 6GHz.

So, Wi-Fi 7 doesn't mean a whole lot right now. There's nothing to be gained by buying the Eero Max 7 today rather than six months down the line, since almost no current hardware can take advantage of the new wireless standard. And by the time we're all toting our Wi-Fi 7 laptops around, the Eero will be facing competition from others, and it remains to be seen how it will stack up.

No matter how excited you may be to try out the latest and greatest Wi-Fi technology, therefore, I'd suggest you hold fire, at least until you're using a Wi-Fi 7 laptop on a regular basis. In the meantime, maybe give those poor maligned Wi-Fi 6E devices a proper innings before they're fully eclipsed – as they certainly will be – by the next-generation standard. ■

DOWNLOADS, MB/sec, 5GHz	Bathroom	Bedroom	Kitchen	Living room	Study
Asus ZenWiFi XD5	39	39	36	35	38
Mercusys Halo H80X	38	42	37	36	80
Amazon Eero Max 7	40	65	64	64	78
Linksys Velop Pro 6E	82	86	71	71	81
Netgear Orbi RBKE963	73	100	79	77	118
TP-Link Deco XE200	97	107	75	84	99

UPLOADS, MB/sec, 5GHz	Bathroom	Bedroom	Kitchen	Living room	Study
Asus ZenWiFi XD5	16	17	15	14	16
Mercusys Halo H80X	14	17	12	13	24
Amazon Eero Max 7	15	20	16	27	28
Linksys Velop Pro 6E	23	24	21	23	25
Netgear Orbi RBKE963	24	26	26	28	41
TP-Link Deco XE200	29	31	28	30	30

VERDICT

★★★☆☆

A generation leap in performance, but at a very high price.

Darien Graham-Smith

PRICE Free **WEB** calibre-ebook.com/about **NEEDS** Windows 10 or 11, MacOS or Linux

Calibre 7.0

Ebook manager

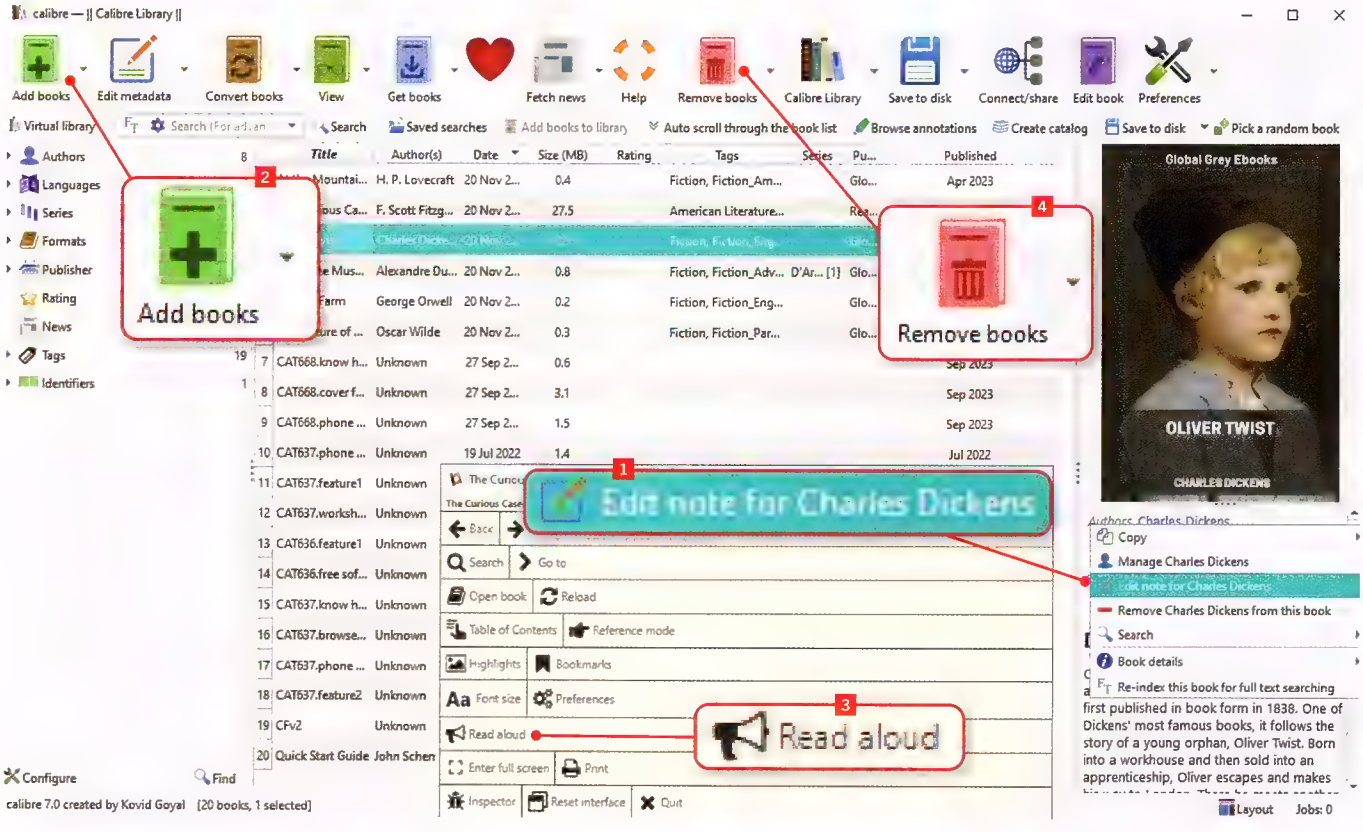
This excellent open-source software is the best way to read and manage ebooks on your computer. Calibre lets you easily convert ebooks from one format to another, edit their contents and covers, download articles from the web, back up and share your library, and much more.

Although the program is regularly updated with improvements and bug fixes, Calibre 7.0 is the first major update since July 2022. Its most notable new feature is the ability to add notes to the books in your library, so you can store useful information about the author, publisher, genre and other categories. These notes can include reviews, images and web links – for example, to relevant Wikipedia articles – and can be exported as separate files. You can browse and search all the notes you create by pressing Ctrl+Shift+N.

It's also now possible to attach extra data files to books, such as alternate covers or supplementary documents. Click the down arrow next to 'Add books' and select 'Add data files to selected book records'. Alternatively, right-click a book and choose 'Edit metadata' then 'Manage data files'.

Calibre 7.0 introduces support for audiobooks in the EPUB format – sometimes called 'Audio EPUB' – letting you listen to books as well as read them. When you open one of these titles in the program's 'E-book viewer', right-click and choose 'Read aloud' to hear the audio recording.

Additionally, Calibre now has its own private 'recycle bin'. This means if you accidentally delete a book, you'll be able to recover it directly through the program rather than from the Windows recycle bin. Click the down arrow next to the 'Remove books' button and select 'Restore recently deleted'.



1 To use Calibre's new Notes feature, select a title in your library to display it in the 'Book details' panel on the right. Right-click the author's name or one of the tags, and choose 'Edit note for...'. Add content to your note then click OK to save it.

2 You can also attach files to your books if you want to store different covers or extra information in your library. Select a title then click the down arrow next to the 'Add books' button and choose 'Add data files to selected book records'.

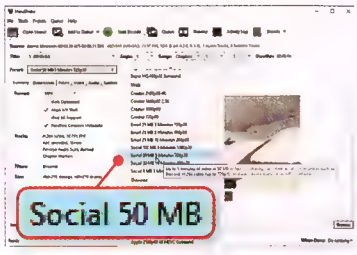
3 Calibre now supports Audio EPUB files, which means you can listen to audiobooks you download in that format from sites such as LibriVox (**https://librivox.org**). Right-click an audiobook in the 'E-book viewer' and select 'Read aloud'.

4 When you delete a book from your Calibre library, you'll now be given a few seconds to cancel the action. To quickly recover deleted books, click the down arrow next to the 'Remove books' button and select 'Restore recently deleted'.

VIDEO CONVERTER

HandBrake 1.7

WEB handbrake.fr/downloads.php **NEEDS** Windows 10 or 11, macOS or Linux

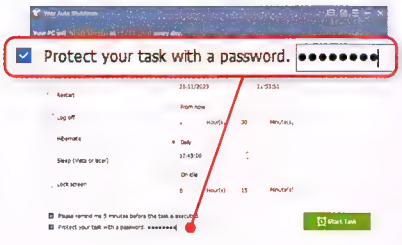


Unlike other video converters, which are either crammed with junk or restrict features to their paid-for versions, HandBrake is completely free to use and supports most video and audio formats. The latest release updates the program's extensive range of presets, which let you choose the optimum resolution and file size for the videos you convert, depending on how you plan to use them – such as posting online, sending by email or copying to a mobile device. These include new Social presets, so you can quickly optimise videos to share on Facebook, Instagram or TikTok – just choose a Social option from the dropdown Preset menu (see screenshot). HandBrake now focuses on improving the quality of converted content, rather than 'deinterlacing' (which changes the frame rate of videos), and says its new approach is better suited to live-action clips and captures of screen activity.

SYSTEM TOOL

Wise Auto Shutdown 2.05

WEB www.wisecleaner.com/wise-auto-shutdown.html
NEEDS Windows 10 or 11

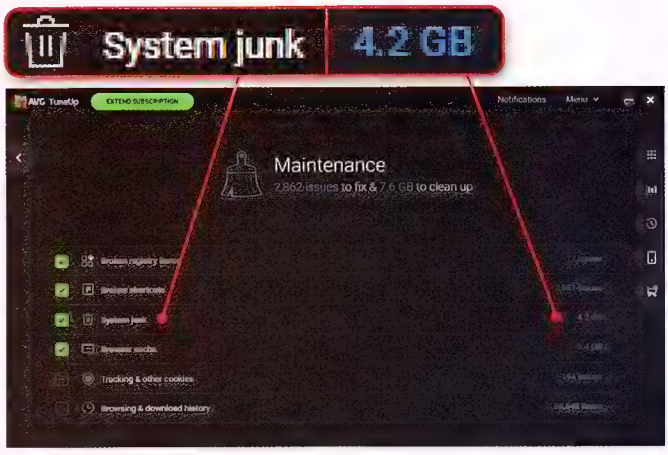


Setting Windows to turn off your PC automatically involves using its convoluted Task Scheduler tool. Wise Auto Shutdown offers a much easier method, allowing you to shut down, restart, log off, hibernate or lock the screen of your computer at the time and frequency of your choice – in just a couple of clicks. Simply select the task you want to perform and either specify a time and date, choose to perform the task at the same time every day, or have it run when your PC has been idle for a certain length of time. Tick the box 'Please remind me 5 minutes before the task is executed', so you have time to save your work before your system shuts down or restarts. The latest version of Wise Auto Shutdown adds the useful option to protect your tasks with a password (see screenshot), so no one can mess with your settings. Enter a password in the box before you click Start Task.

"Wise Auto Shutdown offers a much easier method, allowing you to shut down, restart, log off, hibernate or lock the screen of your computer at the time and frequency of your choices."

Should I pay for?

Choose the right version of software



"Our initial scan uncovered a worrying number of problems, including nearly 5,000 broken registry items, 2,700 broken shortcuts and 4.2GB of 'system junk'"

AVG TuneUp for PC

WEB www.avg.com/en-au/avg-pctuneup
PRICE From $34.99 per year Free trial: 7 days **NEEDS** Windows 7, 8.1, 10 or 11

AVG was once best-known for its free antivirus software, but since it was bought by Avast in 2016 it has focused more on paid-for tools such as AVG TuneUp. This claims to "make an old PC live longer or a new PC run better" by finding and removing junk.

Our initial scan uncovered a worrying number of problems, including nearly 5,000 broken registry items, 2,700 broken shortcuts and 4.2GB of 'system junk' (see screenshot). As we regularly clean our PC using built-in Windows tools and third-party software, these figures seemed excessive and a closer inspection revealed most of the 'issues' to be negligible or non-existent.

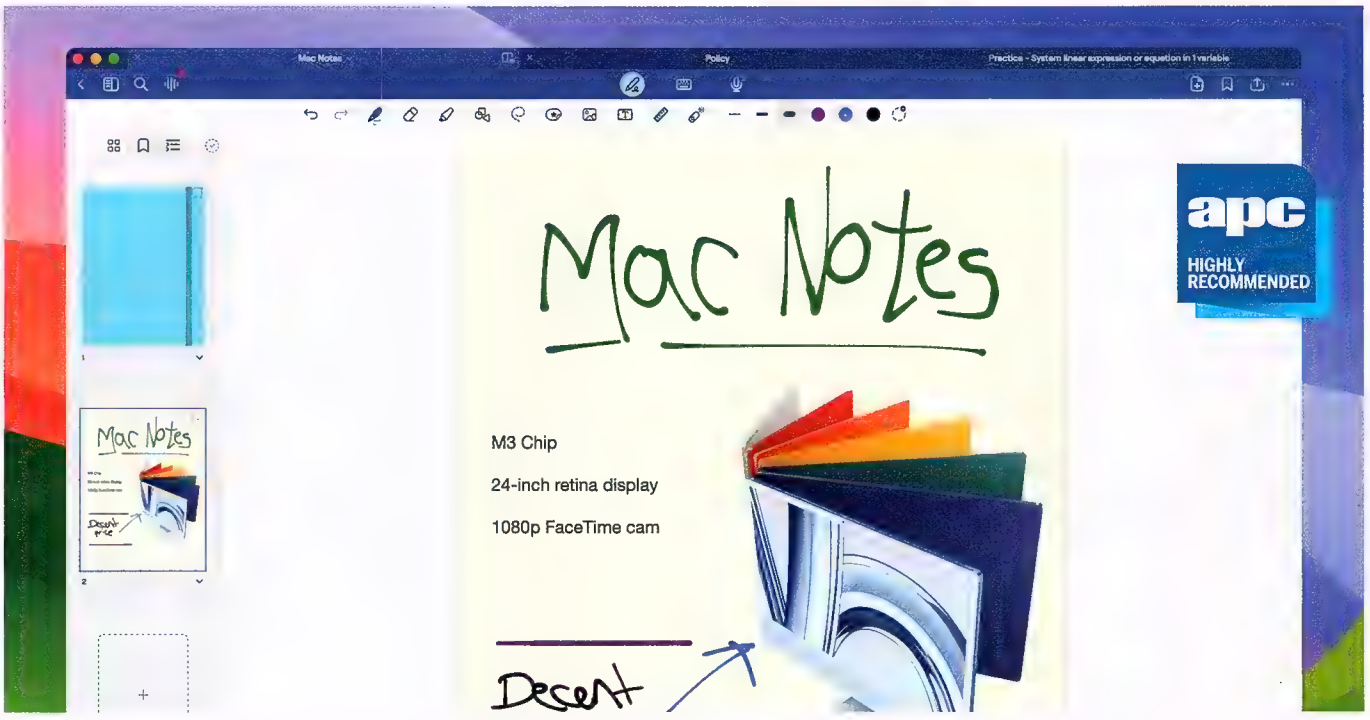
When we moved on to TuneUp's 'Speed up' tab, it told us that no 'unnecessary programs' were found on our PC, without explaining what that meant (or including itself). More usefully, it told us which tools were potentially slowing our PC and let us put them to 'sleep', but its list of all our installed software didn't include Microsoft Store apps.

Other functions such as checking our hard drives for errors, and defragmenting them, are already included in Windows, while TuneUp's driver updater performed only a perfunctory check. It seemed more interested in promoting other AVG products including its mobile app and internet security suite.

Note too that, after the first year, a subscription to AVG TuneUp auto-renews at a wallet-busting $72.99. Considering that tools such as BleachBit (www.bleachbit.org) and O&O AppBuster (**www.oo-software.com/en/ooappbuster**) do a better clean-up job for free, that's a ridiculous price to pay.

OUR VERDICT: DON'T PAY FOR IT

AVG TuneUp is a relic of a bygone era, when all-in-one PC-optimisation tools seemed like the best solution to performance problems. There are now more nuanced and accurate programs available that you don't need to pay for. ■



PRICE Free (IAPs $14.99 per year/$35.99 one-time purchase) **WEB** goodnotes.com **NEEDS** macOS 12.3 or later

The iCloud sync features are well worth having but do require a purchase.

Goodnotes 6

AI smarts could help you become a smarter note taker

Goodnotes 6 is the latest version of the popular note-taking app and PDF editor and the big question for many will be whether it's worth an upgrade from the previous version. If looks alone were to make that decision then, yes. The first big upgrade in four years feels fresh thanks to a new interface that remains intuitive to use. But the most important thing is whether or not the many extra features are going to prove useful, particularly if you're using the Mac version.

The developers of this app clearly have the iPad first and foremost in their minds. After all, it's the device that the app was originally designed for in 2011 and many love it because you can freely handwrite notes. Writing by hand is more cumbersome on a Mac but if you try it, you'll find that it will pick up on spelling mistakes. Not only that, it'll suggest alternative words and then enter them on the page in your own handwriting (or an interpretation of it – we did find this was a bit hit and miss).

There are lots of other neat new features. Goodnotes 6 can predict and finish what you're writing if you have an Apple silicon Mac (using the Neural Engine). You can also scribble over content you want to erase or draw a circle around items you want to select and move – both features make editing feel more natural. Typists aren't left in the cold. Select text and choose AI Typing to fix grammar and spelling, change the tone of your words, paraphrase sentences or make them longer or shorter.

Whichever way you decide to create your notes, the app now goes to great lengths to make sure they're presented just as you'd want them. When creating a notebook, you can choose the size, orientation and colour of the pages and select different papers, whether that be dotted, squared, ruled, legal or columned. The selection stretches to planners and music papers, and you can also buy more.

But what's that? Buy? 'Fraid so. Although you can get free content such as cards, stickers and interactive exam preps (which have AI maths assistance that checks your work), some are confined to subscribers while others require additional cash to be splashed. And yes, subscribers. You can buy Goodnotes 6 outright for access to the macOS, iPadOS and iOS apps with iCloud sync but you need to subscribe for access to the Android, Windows and the web versions too.

Still, it doesn't detract from what is a solid offering. While it's a tad clumsy to use on a Mac if you want to handwrite notes, Goodnotes 6 remains powerful. It adds audio recordings and continues to offer great mark-up abilities for PDFs, superb search and collaboration functions too. ■

"When creating a notebook, you can choose the size, orientation and colour of the pages and select different papers, whether that be dotted, squared, ruled, legal or columned."

VERDICT

★★★★☆

A solid app with some promising AI experimental features that help it stand out from the crowd. **David Crookes**

DEVELOPER OSGeo Foundation **WEB** https://live.osgeo.org **LICENCE** LGPL v2.1

OSGeoLive 16.0

Uncharted no more – Nate Drake maps out the array of geospatial tools on offer in the specialist distro OSGeoLive.

OSGeoLive is an OS that allows users to deploy a wide variety of open source geospatial software. In other words, this is a niche distro that will chiefly interest scientists and explorers.

It's sponsored by the OSGeo Foundation, a non-profit that supports geospatial open source software development.

The OS itself is based on Lubuntu, though the number of bundled apps means that the live ISO is over 4GB. There's also an optional preconfigured VMDK disk image for virtual machines.

As the name suggests, the distro works perfectly well in live mode but more recent versions of OSGeoLive can also be installed to a hard disk with 20GB or more of space.

You may want to do this for the sake of security, as the default root password is 'user'. Similarly, passwords for the bundled apps are listed in a plain text file on the desktop, though in fairness they are only for programs that work with publicly available open source data.

If you decide to proceed with setup, you'll notice that the installer is no different from Lubuntu's – indeed, the splash screen actually uses the name of Lubuntu rather than OSGeoLive. One quirk we did notice was that the installer defaults to German, though you can click Deutsch in the drop-down menu easily enough to switch languages.

As it's based on Lubuntu, this is a fully-fledged operating system with access to Ubuntu repositories, so in theory it could be used as your main OS if you have use for the bundled geospatial software.

This would require some technical chicanery, though, because Lubuntu's Muon package manager is noticeably absent, as are the usual tools you'd need for an OS suitable for day-to-day use, such as an office suite and media player. Still, this isn't the intended purpose of OSGeoLive, which focuses on allowing you to store, view, edit and analyse spatial data of all kinds.

OSGeoLive categorises the various geospatial mapping and data analysis tools into folders on the desktop, which contain app shortcuts.

As hefty as the ISO is, it's clear there's been some effort to cultivate only the best Linux tools. Upon login, you'll see the desktop contains a series of folders that are used to break these tools down into categories such as Navigation And Maps and Spatial Tools.

For those who are new to geospatial software, there's a shortcut to a folder full of sample data, such as maps and detailed images. There's a number of free maps, and tools such as JOSM (Java OpenStreetMap Editor) have helpful wizards and welcome pages for those using them for the first time. Some of the tools are standalone but others are designed to be run in the default Firefox browser (currently version 116.0.2).

One notable web app is Jupyter Notebook, which can create and share documents that contain live code, equations and visualisations. It can be used for data cleaning and transformation, numerical simulation, statistical modelling and even machine learning.

Monteverdi is one of the more useful standalone apps. It's an open source visualisation tool that works well at data compression. It takes advantage of the image processing tools in OTB (Orfeo Toolbox).

The latest version of OSGeoLive has also undergone some pruning. For instance, we were unable to find Mapnik when searching via the app launcher. This open source toolkit for developing mapping applications was present in previous iterations of OSGeoLive.

The same is true for MapSlicer, an app for creating graphical overlays of standard maps such as those in OpenStreetMap. Since both tools are still in active development, we assume the OSGeo community had its own reasons for removing them from the distro. ■

"As hefty as the ISO is, it's clear there's been some effort to cultivate only the best Linux tools."

VERDICT

★★★★☆

OSGeoLive is a niche distro that does one thing very well in offering a Swiss army knife of precision geospatial tools. **Nate Drake**

Luxury TABLETS

Tablets arrived with a bang and then seemed to whimper away, with only the iPad standing strong. But now they're back in a variety of guises. Stuart Andrews takes his tablets seriously.

ON TEST...
Amazon Fire Max 11
Apple iPad (10th gen)
Apple iPad Pro 12.9 (6th gen)
Lenovo Tab P12
OnePlus Pad
Samsung Galaxy Tab S9 Ultra
Apple iPad Air (5th gen)
Google Pixel Tablet
Honor Pad 8
Samsung Galaxy Tab S9
TCL NXTpaper 11

Is it time for a tablet renaissance? After the initial explosion of devices in the wake of the Apple iPad's launch back in 2010, tablets rapidly went out of fashion. Amazon carved out a niche for its family-friendly Kindle Fires geared towards content consumption, but only Samsung has shown greater ambitions.

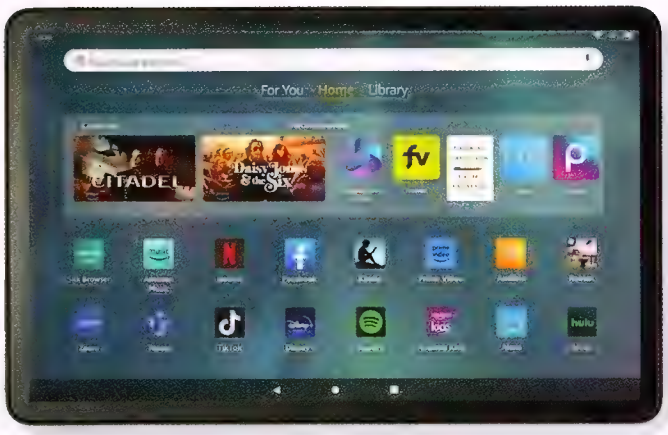
Now things are changing. The iPad Pro and iPad Air have proven there's a strong case for creativity and productivity on tablets, while Lenovo and Samsung have both launched big-screen tablets designed to show that Android can do this stuff as well.

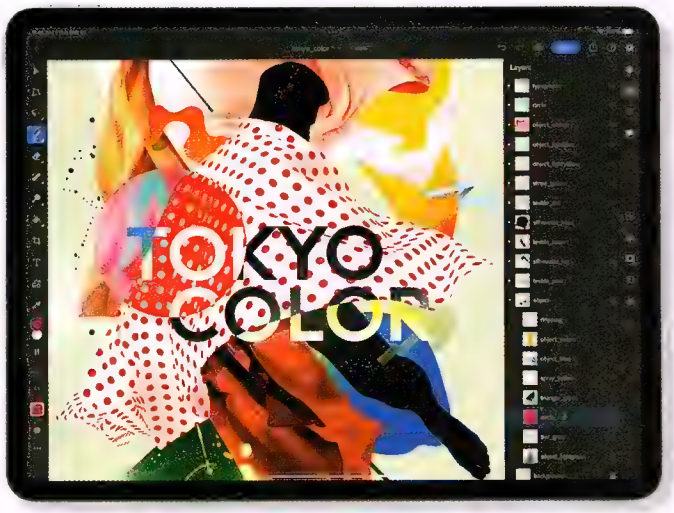
This year's Tablet Labs includes great premium devices you can use to watch blockbuster shows and movies or plan your next holiday online. And we still have plenty of budget-friendly offerings.

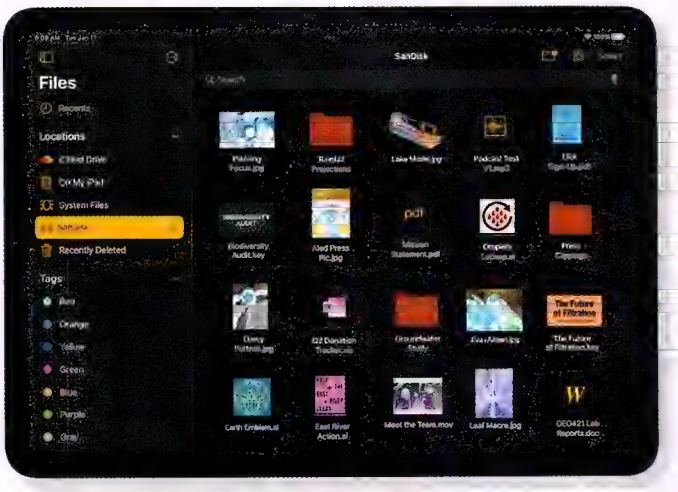
But we've focused on tablets that can handle more demanding applications. That could be working on the move, creating podcasts, editing photos and videos – and from anywhere you choose. These devices have the power and presentation to do it all.

We hope you find a tablet in our group test t that could make a real difference to the way you live and work.

10:08


For You
Home
Library
CITADEL
Daisy Jones & the Six


TOKYO COLOR


Files
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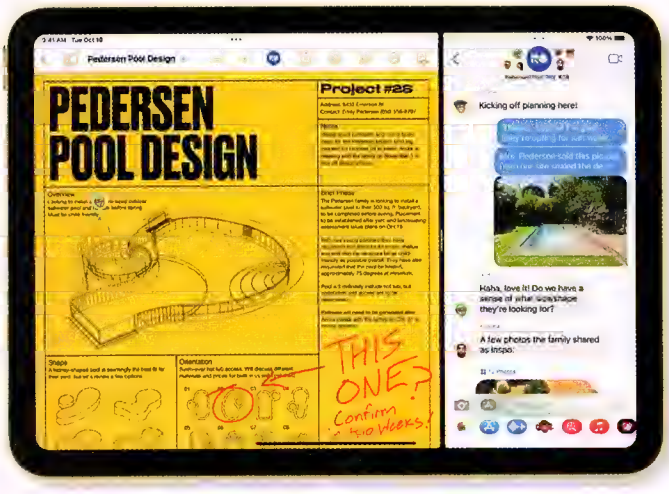
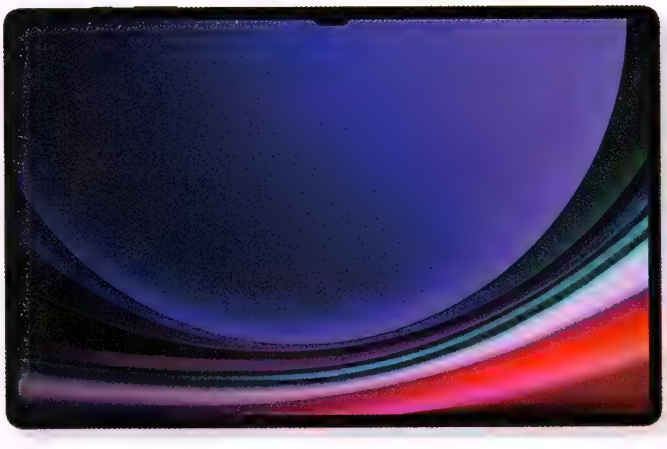
Recently Deleted
Tags


Pedersen Pool Design
PEDERSEN POOL DESIGN
Project #26
THIS ONE?
Kicking off planning here!
Haha, love it! Do we have a sense of what size/shape they're looking for?
A few photos the family shared as inspo:

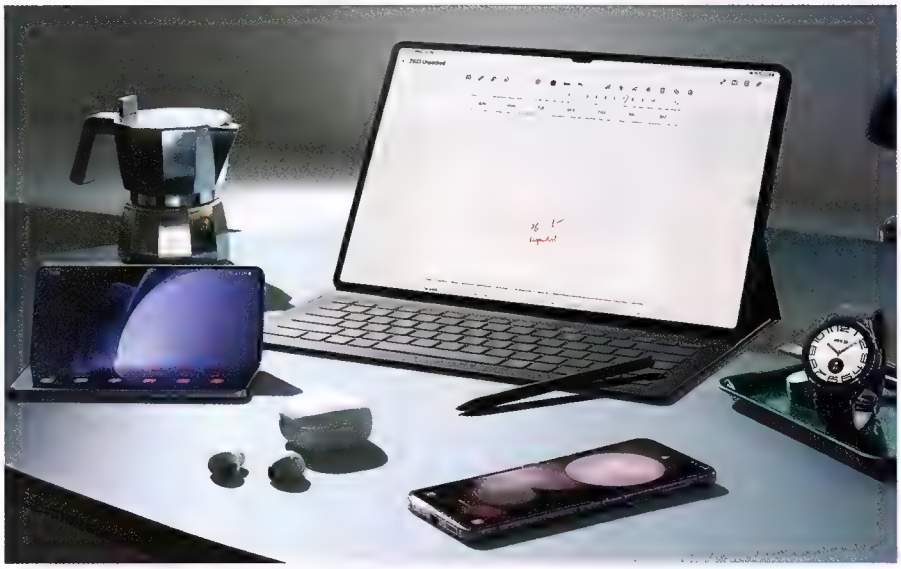


How to beat the tablet-buying blues

It's worth spending a few minutes thinking carefully about what you want from a tablet, as it could save you a lot of money in the longer term.

You might think it doesn't need saying, but buying a tablet is not like purchasing any other type of computer – or even like buying a new phone. Purchase a new laptop and you're buying a standardised device that fits into a well-established ecosystem. Your "Windows experience" won't differ greatly from one laptop to another, and the same is true if you're a MacBook fan. You'll have access to the same hardware accessories and software choices whether you spend a little or a lot.

Tablets are different. The screen and ergonomics can transform the way your slate works and handles. The software may support multitasking and a wide range of creative and productivity applications, or it may focus more on content consumption. Some tablets have accessories that make them significantly more flexible and useful. With others, you'll be lucky to find a case that fits. If you don't factor all of this into your decision, you could make a choice you later regret.



A keyboard can transform your tablet into a versatile productivity tool.

It's all about the screen

We can't say this enough: the screen defines the tablet, including how you can use it, how it's going to feel and work in your hands, and how useful it's going to be for productivity and creative apps – or simply bingeing Netflix while in bed.

Size and resolution are key. Go too big, and you may have a tablet you find less portable or manageable, but go too small and you'll find it hard to work effectively, particularly when it comes to multitasking. Meanwhile, opting for a higher resolution – 1600p or above rather than the basic Full HD 1080p – will give you a crisper image and smoother text, which can often compensate for a slightly smaller screen size.

Beyond that, look for brightness and colour depth. The brighter the tablet, the easier it will be to use in a range of different situations, and the better the experience when watching video or editing images. The higher the colour depth, as indicated by its coverage of the sRGB and DCI-P3 colour gamuts, the richer and more natural the image is going to be, particularly if those colours are accurate as well.

OLED screens almost always have an advantage over IPS panels when it comes to colour gamut coverage. To the point where if you see the word OLED (or AMOLED, or Super AMOLED; they're all variations on a theme) then you can be confident of rich colours and superb blacks in particular.

Don't write off IPS screens, though. These can also produce stunning results, and if you examine our graphs you'll see some tablets with IPS panels that produce excellent colour coverage and accuracy.

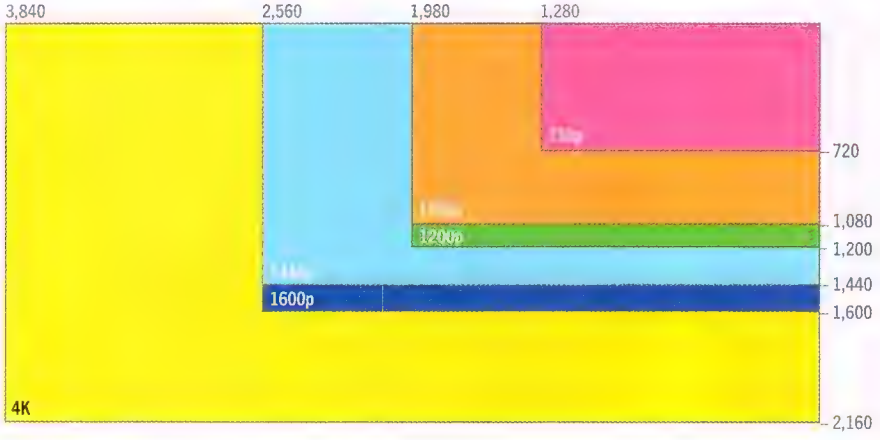
Buy for comfort and resilience

Screen size is the most important bit, but weight, materials and design also have an impact. Slimmer and lighter is usually better, but curves and grippable surfaces can also make a tablet much easier to use. All-metal and/or unibody constructions are now the norm, but plastics can be just as resilient, as anyone who's seen a toddler abuse a cheap Amazon Fire tablet can tell you with confidence.

Get the speed you need

Performance isn't critical if you're mainly browsing the web, participating in video

COMMON RESOLUTIONS (BY PIXEL COUNT)



calls or watching films, but it's crucial if you're planning to do creative work, run productivity apps or play games. You should opt for models with faster processors and 4GB or more of RAM – and preferably 6GB or more.

How fast is fast? The Apple M1 and M2 processors in the new iPad Air and Pro models set the pace, but you can get strong results from the fast Qualcomm Snapdragon or MediaTek Dimensity chipsets. We've done extensive benchmarking across all of this month's tablets to help you make your choice.

ABOVE Operating costs: iOS integrates seamlessly with macOS.

Software counts

Don't underestimate the impact software will have on how you use your tablet. Apple again leads the way here, not just in terms of how effective and feature-rich its iPadOS software is, but also in terms of the range and excellence of the tablet-specific software available for iPad. It's still the best choice for creative apps and games.

Android continues to suffer from a lack of serious applications designed for tablets, and it's hugely irritating when forced to use apps designed originally for phones, which make no real use of a larger tablet screen area.

What's more, the variations on Android that tablet manufacturers install vary dramatically in terms of features and usability. In particular, multitasking and multi-window support will work very differently from tablet to tablet. Samsung and Lenovo know what they're doing, but don't assume that everybody does.

Cameras and connectivity

The received wisdom is that anyone who uses a tablet as a camera is a selfish, irritating mug – and here the received wisdom is absolutely right. However, cameras are a core feature, both at the front for virtual meetings and web chats, and at the back for scanning documents or photographing textures to then use in digital art.

The vast majority of tablets have just one connection, with the vast majority now using USB-C. This will cover charging and external storage, while some tablets will support wider connectivity to displays and peripherals; a definite plus if you're planning to use your tablet for work. Bluetooth is also useful for connecting headphones, mice and keyboards, while Wi-Fi connectivity is critical for your internet connection. Wi-Fi 6 should be your absolute minimum, but go for Wi-Fi 6E if you can.

Ample storage

Storage still tends to be in short supply on tablets, and that can cause problems. Apps, games and media have all become increasingly demanding when it comes to storage space. If you can, opt for 128GB to 512GB over basic 64GB variants, with the latter only suitable for undemanding users – although if you can expand storage through microSD cards or external drives then it's survivable. For instance, films and TV shows can be stored on a microSD card without a big penalty in terms of the loading times.

Battery life

Battery life tends to be less of a concern with tablets than laptops, but that doesn't mean it's unimportant. Even if your tablet never leaves the house, you should look for enough to get through an average day away from the mains, and preferably more. Ten hours is adequate, 14 hours is brilliant.

However, watch out for manufacturer figures. These tend to reflect usage with the screen brightness turned right down and only basic and background tasks running. Working at full brightness and running demanding apps or games will see the battery level drop much faster.

The other factor is time. After a year or two of use, your battery's capacity may have dipped down to 80% or so of its original level, so the ten hours of life is now eight. The higher the initial figure, the happier you'll be a few years down the line.

The whole ecosystem

Here's another factor many buyers miss. When you buy a tablet, you're buying into an ecosystem of cases, covers, keyboards, styluses, cloud services and peripherals. As the biggest seller, the iPad family has the most extensive ecosystem, with Samsung and Lenovo faring best of the Android tablets.

A range of third-party Bluetooth keyboards and styluses will work across most Android tablets, but getting something specific to your tablet could be tricky. If there's something you know you're going to need to be productive, make sure it's available for your chosen model before you buy.

WARRANTIES, REPAIR & RELIABILITY

Tablets are rarely easy to repair. After all, the emphasis here is on svelte design, and that almost always translates into glues rather than screws. This is why it's worth actually looking to see what warranty your tablet comes with (almost always a single year) and how well it fares for reliability.

Apple leads the way for reliability with a customer 93% satisfaction score to Samsung's 90%, while Lenovo scored 87% and Amazon 85%. All of this is also reflected in the prices of their respective tablets.

	Amazon Fire Max 11	Apple iPad (10th generation)	Apple iPad Air (5th generation)	Apple iPad Pro 12.9 (6th generation)	Google Pixel Tablet
RATING	★★★☆☆	★★★★☆	★★★★☆	★★★★★	★★★☆☆
Base storage option	64GB	64GB	64GB	128GB	128GB
Starting price [1]	$399	$749	$999	$1,899	$899
Storage options [1]	128	256GB ($999)	256GB ($1,249)	256GB ($2,079), 512GB ($2,429), 1TB ($3,129), 2TB ($3,829)	256GB ($999)
Cellular option [1]	✗	64GB ($999), 256GB ($1,249)	64GB ($1,249), 256GB ($1,499)	128GB ($2,149), 256GB ($2,329), 512GB ($2,679), 1TB ($3,399), 2TB ($4,099)	✗
Generation	1	10	5	6	1
Supplier	tristaronline.com.au	apple.com/au	apple.com/au	apple.com/au	store.google.com
Dimensions (WDH)	259 x 164 x 7.5mm	249 x 180 x 7mm	248 x 179 x 6.1mm	281 x 215 x 6.4mm	258 x 169 x 8.1mm
Weight	490g	477g	461g	682g	493g
SUPPORT AND RELIABILITY					
Warranty	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB
Overall satisfaction [2]	79%	86%	86%	86%	N/A
Reliability satisfaction [2]	85%	93%	93%	93%	N/A
IP rating	✗	✗	✗	✗	✗
CORE COMPONENTS					
Chipset	MediaTek MT8188J	Apple A14 Bionic	Apple M1	Apple M2	Google Tensor G2
Number of cores	8	6	8	8	8
Clock speed	2 x 2.2GHz, 6 x 2GHz	3GHz	3.2GHz	3.5GHz	2 x 2.9GHz, 2 x 2.4GHz, 4 x 1.8GHz
Installed RAM	4GB	4GB LPDDR4X	8GB	8GB to 16GB	8GB
Graphics chip	Mali-G57 MP2	4-core A14	8-core M1	10-core M1	Mali-G710 MP7
CONNECTIVITY AND EXPANSION					
Wi-Fi	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6E	Wi-Fi 6
Bluetooth	5.3	5.2	5	5.3	5.2
GPS	✗	5G models only	5G models only	5G models only	✗
NFC	✗	✗	✗	✗	✗
Audio jack	✗	✗	✗	✗	✗
microSD	✓	✗	✗	✗	✗
Charging port	USB-C 2	USB-C 2	USB-C 3.2 Gen 2	USB-C 4/Thunderbolt 4	USB-C 3.2 Gen 1
USB speed	480Mbits/sec	480Mbits/sec	10Gbits/sec	40Gbits/sec	5Gbits/sec
DISPLAY					
Screen size and type	11in IPS	10.9in IPS	10.9in IPS	12.9in mini-LED	11in IPS
Max refresh rate	60Hz	60Hz	60Hz	120Hz	60Hz
Resolution	2,000 x 1,200	2,360 x 1,640	2,360 x 1,640	2,732 x 2,048	2,560 x 1,600
Aspect ratio	16:9	1.44:1	1.44:1	4:3	16:10
Pixel density	213ppi	264ppi	264ppi	264ppi	276ppi
OTHER FEATURES					
Rear camera(s)	8MP	12MP	12MP	12MP/10MP	8MP
Front camera	8MP	12MP	12MP	12MP	8MP
Fingerprint reader	✓	✓	✓	✗	✓
Face unlock	✗	✗	✗	✓	✗
Battery capacity	27.8Wh	28.6Wh	28.6Wh	40.9Wh	27Wh
Max charging	15W	20W	30W	45W	15W
Charger supplied	9W	20W	20W	20W	15W speaker dock
SOFTWARE					
Base OS	Android 11	iPadOS 16	iPadOS 16	iPadOS 16	Android 14
Added layer?	Fire OS 8.3	✗	✗	✗	✗
App store	Amazon Appstore	Apple App Store	Apple App Store	Apple App Store	GooglePlay Store
OFFICIAL ACCESSORIES					
Keyboard	Fire Max 11 Keyboard Case ($129)	Magic Keyboard Folio ($399)	Smart Keyboard Folio ($299), Magic Keyboard ($399)	Magic Keyboard ($399)	✗
Stylus	✗	Apple Pencil 1st gen ($159)	Apple Pencil 2nd gen ($157)	Apple Pencil 2nd gen ($157)	✗
Other	Magnetic Slim Cover ($TBA)	Smart Folio ($129)	Smart Folio ($129)	Smart Folio ($129)	Pixel Tablet Case ($139)

[1] Prices correct at time of going to press but are subject to change. [2] Based on reader feedback in PC Pro Excellence Awards 2023. N/A means not enough feedback for reliable results.

	Honor Pad 8	Lenovo Tab P12	OnePlus Pad	Samsung Galaxy Tab S9	Samsung Galaxy Tab S9 Ultra	TCL NXTpaper 11
	★★★☆☆	★★★★☆	★★★★★	★★★★☆	★★★★★	★★★☆☆
	128GB	128GB	128GB	128GB	256GB	128GB
	$400	$547	$749	$1,299	$1,999	$289
	✗	✗	✗	256GB ($1,499)	512GB ($2,199), 1TB ($2,699)	✗
	✗	✗	✗	128GB ($1,549), 256GB ($1,749)	256GB ($1,749), 512GB ($2,449), 1TB ($2,949)	✗
	1	1	1	9	9	1
	aliexpress.com	lenovo.com	amazon.com.au	samsung.com	samsung.com	amazon.com
	279 x 174 x 6.9mm	293 x 191 x 6.9mm	258 x 189 x 6.5mm	254 x 166 x 5.9mm	326 x 209 x 5.5mm	257 x 162 x 6.9mm
	520g	630g	552g	500g	737g	462g
	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB
	N/A	81%	N/A	85%	85%	N/A
	N/A	87%	N/A	90%	90%	N/A
	✗	✗	✗	IP68	IP68	✗
	Qualcomm Snapdragon 680	MediaTek Dimensity 7050	MediaTek Dimensity 9000	Qualcomm Snapdragon 8 Gen 2	Qualcomm Snapdragon 8 Gen 2	MediaTek Helio P60T
	8	8	8	8	8	8
	4 x 2.4GHz, 4 x 1.9GHz	2 x 2.6GHz, 6 x 2GHz	1 x 3.1GHz, 3 x 2.8GHz, 4 x 1.8GHz	1 x 3.4GHz, 4 x 2.8GHz, 3 x 2GHz	1 x 3.4GHz, 4 x 2.8GHz, 3 x 2GHz	4 x 2GHz, 4 x 2GHz
	6GB	8GB	8GB	8GB/12GB	8GB/12GB	4GB
	Qualcomm Adreno 610	Mali-G68 MC4	Mali-G710 MP10	Qualcomm Adreno 740	Qualcomm Adreno 740	PowerVR GE8320
	Wi-Fi 5	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 5
	5.1	5.1	5.3	5.3	5.3	5
	✗	✗	✗	✓	✓	✗
	✗	✗	✗	✗	✗	✗
	✗	✗	✗	✗	✗	✗
	✗	✓	✗	✓	✓	✓
	USB-C 2	USB-C 2	USB-C 2	USB-C 3.2 Gen 1	USB-C 3.2 Gen 1	USB-C 2
	480Mbits/sec	480Mbits/sec	480Mbits/sec	5Gbits/sec	5Gbits/sec	480Mbits/sec
	12in IPS	12.7in IPS	11.6in IPS	11in AMOLED	14.6in AMOLED	11in NXTVISION
	60Hz	60Hz	144Hz	120Hz	120Hz	60Hz
	2,000 x 1,200	2,944 x 1,840	2,800 x 2,000	2,560 x 1,600	2,960 x 1,848	2,000 x 1,200
	16:9	16:9	7:5	16:10	16:10	5:3
	194ppi	273ppi	296ppi	274ppi	239ppi	213ppi
	5MP	8MP	13MP	13MP	13MP/8MP	8MP
	5MP	13MP	8MP	12MP	12MP	8MP
	✗	✓	✓	✓	✓	✗
	✓	✗	✗	✓	✓	✓
	7,250mAh	10,200mAh	37Wh	8,400mAh	11,200mAh	8,000mAh
	22.5W	30W	67W	45W	45W	18W
	22.5W	20W	✗	✗	✗	18W
	Android 12	Android 13	Android 13	Android 13	Android 13	Android 13
	Magic UI 6.1	Lenovo ZUI 15	Oxygen OS 13.1	One UI 5.1	One UI 5.1	TCL UI 5
	Google Play Store	Google Play Store	Google Play Store	Google Play Store	Google Play Store	Google Play Store
	Honor Pad 8 Keyboard ($127)	Keyboard Pack ($175)	OnePlus Magnetic QWERTY keyboard ($249)	Keyboard Folio ($249)	Keyboard Folio ($249)	✗
	✗	Tab Pen Plus (included)	✗	S-Pen (included)	S-Pen (included)	✗
	✗	Folio Case ($44)	OnePlus Folio Case ($42)	Book Cover Keyboard ($299)	Book Cover Keyboard ($299)	✗

The folio-style keyboard case is decent given the price.

64GB, $399 | tristaronline.com.au

Amazon Fire Max 11

Affordable, with premium style and strong peripherals, but the software holds it back.

After years of budget Fire and Fire HD tablets, it's easy to forget that some of the initial Kindle Fire tablets were surprisingly premium affairs, running speedy Snapdragon 800-series CPUs and packing 1600p resolution screens. Now Amazon is back in the mid-range tablet business with the Fire Max 11.

Where standard Fire HD tablets are content-consumption devices, the Fire Max 11 has grander ambitions. It's built around an 11in screen with a 2,000 x 1,200 resolution, while the processor is a quad-core MediaTek MT8188J with two ARM Cortex A78 cores running at up to 2.2GHz, plus six A55 cores running at up to 2GHz. Paired with 4GB of RAM, there's significantly more power on tap here than with the sometimes sluggish Fire HD models, making for a more versatile device.

Amazon has made the most of this by producing solid, affordable peripherals for the Fire Max 11. Prime among them is the folio-style keyboard case, which is better than we expected given the $129 price. The layout is more standard and less cramped than the iPad 10th generation's equivalent, and the keys have decent travel and a nice crisp action.

The trackpad is tiny at 85mm wide and 42mm deep, but it works surprisingly well despite the lack of right-click or two-finger tap functions. You could easily get some work done on it. And while the stylus doesn't have the artistic powers of Apple's Pencils, it's great for annotations, sketches and doodles.

There's no serious issue with the screen. With a 213ppi pixel density it's slightly grainy, but it can reach brightness levels of nearly 500cd/m2 and covers 95% of the sRGB gamut. Subjectively, colours don't look as vibrant as on more expensive tablets, but 4K HDR movies on Amazon Prime Video still look great. The audio is also quite impressive, though it loses clarity and starts to sound thin at higher volumes.

As for the performance, the Fire Max 11 isn't going to bother the Lenovo Tab Extreme or any of Apple's iPads in the benchmarks graphs, but it's fast enough for basic productivity tasks and light creative work. Gaming is also an option, through poor frame rates in our tests indicate that you might want to compromise on the resolution and turn down the detail settings. The battery life, however, is nothing short of phenomenal; the Fire Max 11 lasted nearly 20 hours in our rundown test.

In fact, only one thing holds this tablet back: Amazon's Fire OS software. While there are some decent productivity, notes and sketching apps, Amazon's Appstore still falls short of the Google Play Store when it comes to content. We had to sideload many of our test apps, and it's frustrating that so many must-have Android apps just aren't available. Even if you stick to Amazon's favoured apps or Microsoft 365 and Google's web apps, you'll find the Fire OS UI still feels clunky in places, with no support for docking apps or floating windows, and only basic split-screen features. You can't help feeling that an operating system designed for consuming content is being pushed into areas where it's not a natural fit.

Considering the price, that might not matter, and this is a great tablet for using Amazon's services and doing light work at home or on the go. It could even make a decent homework device. But if you're hoping for a tablet that can do more than that, you'll need to look upmarket at more versatile and powerful premium devices.

> "While there are some decent productivity, notes and sketching apps, Amazon's Appstore still falls short of the Google Play Store when it comes to content."

VERDICT

★★★★½

64GB, $749 | apple.com/au

Apple iPad 10th generation

Not as fast or feature-packed as the iPad Air, but a better-value tablet for most people.

There are good reasons why the 10th generation iPad remains the most successful mainstream tablet out there. The updated design, which brings the basic model closer to the iPad Air, works as well held vertically in the hand for web browsing and email as it does placed horizontally on a stand or folio case for productivity work or creative apps. It looks and feels every inch the premium slate.

The lack of an SD card slot for expanding storage won't surprise anyone, but the fact that the single USB-C port is limited to charging and 480Mbits/sec data transfers is disappointing; you won't be connecting to 4K displays at 60Hz. All the same, this is a highly capable device.

What's more, outside of direct comparisons with the iPad Air and iPad Pro models, the 10.9in screen is fantastic, reaching brightness levels of over 500cd/m2 with adaptive brightness on and delivering sharp, high-contrast images, despite black levels that veer too much on the high side to be really dark. The screen covers 94% of the sRGB gamut and 68% of DCI-P3, and it's a pleasure to stream video or engage in some photo or video editing. The sound is surprisingly rich and deep for such a small body, and a definite cut above most budget tablets.

Performance is another strength. While it's not in the same league as the M1 and M2 processors inside the iPad Air and iPad Pro models, the iPad's A14 Bionic is still fearsomely fast, beating even some powerful Android competitors in Geekbench 6 and web-based application benchmarks. It's also significantly quicker in 3D benchmarks, getting close to the scores of the most powerful Android tablets in 3DMark's Wildlife and Wildlife Extreme tests. If you want an iPad that can play the more demanding games in the iPad's extensive library, you don't necessarily need to step up to the iPad Air.

With close to 12 hours of battery life in our tests, it will get you through a good day of work or play without a recharge. The cameras, meanwhile, deliver some of the best stills and video of any tablet, whether you're shooting snaps from the rear or using the front-facing camera to make Facetime calls.

"While it's not in the same league as the M1 and M2 processors inside the iPad Air and iPad Pro models, the iPad's A14 Bionic is still fearsomely fast."

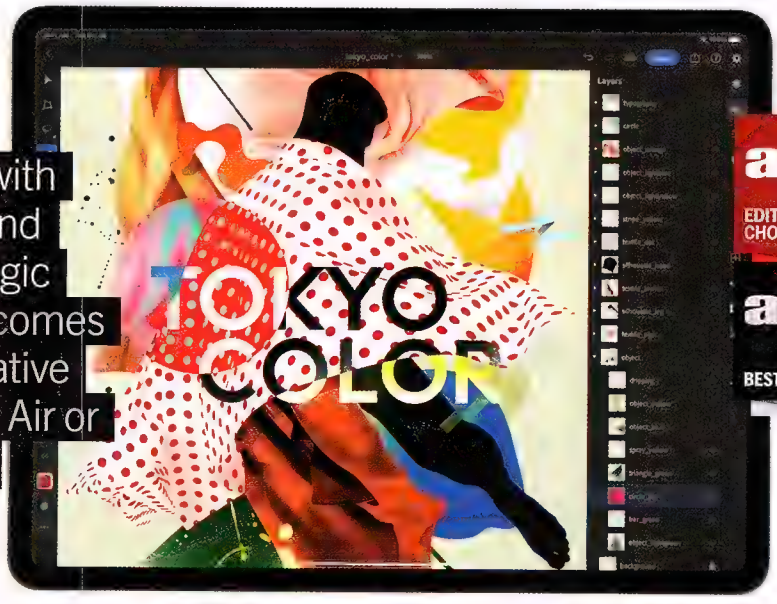
Yet the best reason to invest in the iPad is the software. On the one hand, with its dock and split-screen views, iPadOS has become a mature, highly usable environment for tablets, even if it lacks the flexible multi-window support of Windows or macOS. On the other hand, it gives you access to a superb range of productivity, lifestyle and creative apps that have actually been designed for a tablet rather than a phone.

Just as importantly, the iPad has a rich ecosystem of add-ons to help you make the most of them. We have some reservations about Apple's Magic Folio keyboard case with its slimmed-down punctuation keys and lack of any tilt, but the feel of the keys is crisp and speedy, and it turns the basic iPad into an effective device for getting work done. And while it's annoying that the Pencil requires a Lightning-to-USB adapter, it's a superb tool for digital art and making notes.

The 10th gen iPad still feels overpriced – $749 is a lot to ask for the basic 64GB version and not exactly what you'd call entry-level pricing – but this remains the most powerful and versatile tablet you can buy for this kind of money (although don't ignore the exceptional OnePlus Pad). And the 9th generation iPad from $549, still on sale, is a fine, cost-cutting alternative. If you can afford to spend more, the iPad Air is a stronger choice for serious work or creativity. For most people, though, the iPad will be fast enough, with a good enough screen and connectivity, to do all they want to do on a tablet. In which case, why spend more?

VERDICT

★★★★½



"What's more, with the optional – and expensive – Magic Keyboard, it becomes a serious alternative to the MacBook Air or MacBook Pro."

apc EDITOR'S CHOICE

apc BEST ON TEST

The bright, colourful screen is among the best you'll find on a tablet.

128GB, $1,899 | apple.com/au

Apple iPad Pro 12.9

Too big and expensive for the mainstream, but perfect for well-heeled power users.

The sixth-generation iPad Pro remains the benchmark by which other high-end tablets are judged, thanks to its 12.9in Liquid Retina XDR display and laptop-class M2 processor, which make it a formidably powerful device. It's a handful at 281 x 215mm, with a slightly thicker shell than the smaller iPad to maintain rigidity, but at 682g it's still a lot lighter than any laptop. Until you add the 710g Magic Keyboard, that is. The squarer shape also makes it feel well balanced and easier to hold than some.

The screen is one of the best you'll find. It's bright, hitting 591cd/m2 in everyday use and reaching over 1,200cd/m2 with HDR content, with a peak HDR luminance of up to 1,600cd/m2 for portions of the screen. The miniLED technology ensures deep blacks and stunning levels of contrast, while the colour reproduction is hard to fault, covering 104% of sRGB and 79% of the DCI-P3 gamut. Average Delta E is just 0.24, making it perfect for colour-critical design work, while the 120Hz refresh rate means scrolling and motion is silky. And if you just want to use this awesome display to stream 4K HDR blockbusters, it's brilliant at that as well, even if you'll have some big bars at the top and bottom of the screen.

Audio quality is every bit as good, giving movie scores and sound effects weight and clarity with a degree of stereo spread. You can happily listen to music without feeling you need to connect to a wireless speaker.

The tablet's connectivity also lends itself to more demanding scenarios. You get Wi-Fi 6E and Bluetooth 5.3, but also a USB-C connector that supports Thunderbolt 4, opening up 4K displays, high-speed external drives and docking solutions. If you want to use an iPad as your main computer, there's nothing standing in your way.

What's more, with the optional – and expensive – Magic Keyboard, it becomes a serious alternative to the MacBook Air or MacBook Pro. The iPad Pro attaches to the rear of the keyboard through a magnetic mount, then hovers over the edge of the keypad, for a more ergonomic work environment than traditional tablet keyboards. It helps that it's a laptop-grade effort, with large, flat keys and a mostly standard layout. Plus the kind of action and haptic feedback that quickly gets you typing at speed.

Apple has worked hard to make the iPad Pro work in this way, and while there are some frustrations about the way its Stage Manager multitasking works, it still gives you a familiar environment with resizable windows and proper multitasking. When you're working on tasks that involve collating information across multiple apps or documents, it's much easier to do so on the iPad Pro than nearly any other tablet – aside from the Lenovo Tab Extreme and Samsung Galaxy Tab S9 Ultra.

Beyond all this, the M2 processor ensures you have all the power you need. Paired with 16GB of RAM on the 1TB version we tested, the iPad Pro trashed the competition across all our benchmarks. It chews through even the most demanding apps, and no other tablet makes such an effective – if expensive – games machine. When console ports start hitting Apple's App Store, you can be sure that the iPad Pro will cope. Only the battery lie is slightly disappointing, with the biggest iPad running dry in short of 12 hours of 1080p video playback.

Of course, price is the iPad Pro's big problem. Even the entry-level 128GB version is a fearsome $1,899, with the 1TB version clocking in at a whacking $3,129. If you then want to add the Magic Keyboard and Apple Pencil, you could be looking at spending the best part of $557 on top of that. For that kind of money you could have a 13in or 15in MacBook Air with more RAM and storage, meaning you really have to want the tablet form factor and be happy with iPadOS's limitations to make it worth your while. Still, if that's the case, have no doubts. This is the still the best big-screen tablet of the bunch.

VERDICT

★★★★☆

128GB, $547 | lenovo.com

Lenovo Tab P12

The P12 punches above its price, with specs and speeds that would normally push a tablet over $800.

The Tab P12 slots in beneath the Pad Extreme and the P12 Pro in Lenovo's tablet line, giving you a big 12.7in screen but no OLED technology, and a good spec without being exceptional. For example, rather than a high-end Qualcomm Snapdragon 870 CPU, here the processor is a more modest MediaTek Dimensity 7050, while the panel is a 2,944 x 1,840 resolution IPS display.

The design is typical Lenovo, with a slim but robust aluminium shell in a two-tone storm grey colour, and a narrow 8mm bezel around the screen. It doesn't have the brightness, contrast or vivid colour of the OLED panel on the Tab Extreme, but on its own terms it's perfectly respectable, with a maximum brightness of 434cd/m2 in its Vibrant colour mode, with 95% coverage of the DCI-P3 gamut. Colour accuracy isn't bad on the Vibrant setting, and it is even better on the 405cd/m2 Standard setting, where it has an average Delta E of just 1.04.

Either way, it's a good option for streaming video or browsing the web, particularly with a four-speaker JBL-manufactured Dolby Atmos sound system that produces richer and more spacious audio than you'll find on most other tablets at this price. It's also great for streaming games, once you hook up a Bluetooth controller and have the Nvidia GeForce Now or Xbox Games Pass apps installed.

As for productivity, there's an optional keyboard case, while Lenovo frequently bundles the Tab P12 with its Tab Pen Plus stylus. We tried the latter, and while it's a bit lightweight and plasticky if you're used to Samsung or Apple's styluses, it still offers 4,096 levels of pressure and tilt sensitivity, making it well worth having for taking notes or digital art in supporting Android apps.

On connectivity, the P12 is a step down from the Tab Extreme. Wi-Fi is standard Wi-Fi 6 rather than the speedier 6E, while the USB-C port used for charging is 480Mbits/sec USB 2 rather than 5Mbits/sec USB 3.2 Gen 1. Still, both are adequate for a basic Android tablet, even if they limit what you might want to connect it to.

Unlike the Tab Extreme, the P12 has no ambitions to replace your normal laptop, but it can be a good productivity partner. You can use Lenovo's Freestyle app to use the P12 as a wireless second screen, although both devices must be signed into the same Lenovo ID. This is perfectly possible on non-Lenovo laptops, but a pain nonetheless. Used solo, it supports split-screen views and floating windows, so you can multitask in comfort on the move.

The P12 also works well for video calls and meetings, thanks to a 13MP front-facing camera that produces detailed, well-exposed pictures, and a mic array that does a solid job of picking up your voice with little echo or background racket. The 8MP rear-facing camera isn't as good as the one on the front, but it's still handy for the occasional snap or copying and scanning paperwork.

Needless to say, performance isn't in the same class as the iPad 10th generation or even the OnePlus Pad, let alone the Samsung Galaxy Tab S9 duo or the Tab Extreme. Yet the P12 feels slick and speedy in everyday use, and coped well with creative tasks as well as the basics. You can even squeeze enough 3D power from the Dimensity 7050 CPU to play the odd game, though not at the native resolution or with detail settings set to high.

Battery life could be better – the P12 managed a little over 11 hours of 1080p video playback before it ran out of puff – but overall Lenovo's cheaper premium slate is cracking value, giving you a good screen, excellent audio and decent levels of performance at a reasonable price. If you want a more serious productivity device, spend more on the OnePlus Pad, but if you just want the best of the more affordable Android tablets, this is an excellent option.

"It's a good option for streaming video or browsing the web, particularly with a four-speaker JBL-manufactured Dolby Atmos sound system"

VERDICT

128GB, $749 | amazon.com.au

OnePlus Pad

Smart design, good specs and solid performance in a tablet that doesn't cost the earth.

It's taken a long time for OnePlus to get into the tablet game, but the OnePlus Pad shows it adopting the same successful approach as on its phones. This means not only selecting fast components for the budget and developing its own distinctive software, but also making smart design choices that focus on how people might actually use the OnePlus Pad.

That starts with the 11.6in screen and its unusual 7:5 aspect ratio. Apple decided long ago that 16:9 widescreen wasn't the best fit for tablets; it works brilliantly for watching movies, not so much for productivity or design work. Or for reading or browsing with the tablet held in portrait mode. OnePlus has gone even better. With its squarer aspect ratio, the OnePlus Pad appears to have a similarly sized screen to some of the larger 12.9in to 14in tablets, but without the bulk. Sure, you'll have bigger bars at the top and bottom when you're bingeing Netflix, but it makes for a more versatile device.

It's beautifully made as well, with a slim, rounded profile and a dark green, satin-finish aluminium shell that looks great – and feels great, too. You'll still want a case to protect it, but it feels as solid and as premium as any iPad or Galaxy Tab. We do have reservations about the chunky, circular camera array at the rear, however, which is massive considering it holds only a single 13MP camera. It takes sharp, bright and natural-looking photos, though, as does the 8MP front camera.

The screen itself is excellent for an IPS display. We measured the maximum brightness at 528cd/m2 and the contrast at 1,451:1. It covers a fantastic 93% of the DCI-P3 gamut in the Vivid colour mode, ensuring rich and vibrant colours whether you're streaming video or editing photos, with good colour accuracy to boot. What's more, it updates at 144Hz, giving you gorgeous, smooth scrolling. The sound is equally fantastic, giving you more body and a much wider stereo spread than most rival tablets can achieve.

The aspect ratio makes even more sense once you have the Pad sitting in its optional keyboard folio. This clips onto the back of the tablet magnetically, with a large round hole for the camera module and the keyboard powered from the tablet through pogo pins just about the keypad. This has one negative effect, however, as with the tablet sitting in position on the pins, there's no way to change the fairly upright viewing angle.

> "With the keyboard fitted, the OnePlus Pad makes a functional secondary computer."

On the plus side, the keyboard is very good. It's taken a hit in size to fit within the limited width of the tablet, but the keys are well sized and the action tight. I wouldn't want to make too much use of the tiny 80mm by 42mm touchpad, but it's fine for basic productivity work.

With the keyboard fitted, the OnePlus Pad makes a functional secondary computer, perfect for research and notes or getting a draft of a document done on the move. And while Android isn't as strong as iOS on creative apps, the OnePlus Pad can handle those, too. It helps that OnePlus has really thought about the UI for its Oxygen OS spin on Android, going for an iPad-style dock at the bottom of the screen and supporting both floating windows and split-screen views (though not all apps support them).

This is a fast Android tablet, with the same MediaTek Dimensity 9000 processor as the Lenovo Tab Extreme and 8GB of RAM. That puts it near the top of the Android tablets on test for performance, though behind the iPad Pro and iPad Air, and there's enough 3D horsepower to run most games at medium to high detail settings. What's more, battery life is about as good as it gets. With over 17 hours in our 1080p video rundown tests, only the Amazon Fire Max 11 and TCL NXTpaper 11 showed more longevity.

There are some disappointments – we'd have liked to have seen Wi-Fi 6E, a faster USB-C connection and more storage size (128GB is your only choice) – but if you're looking for a tablet that can work hard and play hard, this is the best Android option outside of Samsung's Galaxy Tabs. And it won't do so much damage to your wallet.

VERDICT

★★★★★

"The best thing about the Galaxy Tab S9 Ultra, though, is its performance. It kicks sand in the face of even the mightiest Android tablets."

256GB, $1,999 | samsung.com

Samsung Galaxy Tab S9 Ultra

The best of the big-screen Android tablets, going toe-to-toe with the iPad Pro.

Even when other Android tablet manufacturers seemed to give up, Samsung kept plugging away, delivering bigger, better and more capable Galaxy Tab S tablets with each new generation. That really paid off with the Galaxy Tab S8 series, arguably the first set of Android tablets to give Apple's iPad range serious competition. And now that goes double for the Galaxy Tab S9 Ultra, which is Samsung's finest tablet yet.

This isn't just about the hardware. Samsung has nailed usability with its One UI, so that you can manage multiple windows and multitask between them, just as you would in Windows or macOS. Even the window-snapping features work in much the same way. And while Lenovo has followed Samsung in providing an alternative, desktop-style UI – this activates when you connect a monitor and keyboard – Samsung's DeX experience is slicker and more consistent.

Place the Galaxy Tab S9 Ultra inside its $299 book cover keyboard, and you have a very viable laptop replacement, provided you can work with a more limited set of Android and web-based apps. It's a shame the typing experience isn't quite up there with Apple's Magic Keyboard or Lenovo's Tab Extreme equivalent, though, especially given the price.

Providing the S-Pen as standard is another smart idea, giving you everything you need for making notes, sketching, annotation and lightweight digital art out of the box.

This doesn't mean the hardware isn't worth shouting about. Quite the opposite, in fact. Samsung has done just about everything possible to minimise the bulk of this huge tablet, while ensuring there's still enough rigidity and something you can grip. It's surprisingly robust for a big device that's only 5.5mm thick, and is even IP68-rated against dust and water.

Other tablets give you a screen on which you can watch movies; the S9 Ultra gives you one on which you could probably make them, though it's good at the entertainment stuff as well. It reaches SDR brightness levels of 592cd/m2, and HDR brightness levels of 765cd/m2. It covers 100% of the sRGB colour gamut with a volume of 181%, and 100% of DCI-P3 with a volume of 128%. Colour accuracy is near perfect, with an average Delta-E of under 0.2. It's almost wasted streaming 4K HDR video from Netflix and Amazon Prime, even if it's a splendid sort of waste. You feel like you should be doing something creative to justify owning this tablet.

As far as connectivity is concerned, the S9 Ultra can't compete with the Thunderbolt 4 port on the iPad Pro: USB 3.2 Gen 1 translates into 5Gbits/sec, which means that DeX struggles with refresh rates when handling external monitors at resolutions above 1080p. Yet Samsung still has one key advantage over any Apple device, and that is enabling you to boost your storage or import photos through a microSDXC slot.

The best thing about the Galaxy Tab S9 Ultra, though, is its performance. It kicks sand in the face of even the mightiest Android tablets – even you, the Lenovo Tab Extreme – while giving the M1 iPad Air and M2 iPad Pro the closest thing they've ever had to competition. Whether you're editing 4K video or high-resolution photos or simply playing *Diablo Immortal*, the Tab Extreme will feel flawlessly speedy and responsive. And while the massive 11,200mAh battery only gives you around 13 hours of video playback before shutting down, that's still good enough for a solid day of work and entertainment, and what do you expect with a screen this size?

In terms of hardware and the core experience, this isn't just the best Android tablet out there, but a real alternative to the iPad Pro. Yet we still have caveats. The S9 Ultra is extremely expensive, and you still won't have access to the full range of pro-level creative and business apps that Apple users take for granted. Yet there's probably enough out there for most mainstream users, and only professionals needing specific tools will struggle to find appropriate software. For many people, this is going to be the big-screen tablet of their dreams.

VERDICT

★★★★★

64GB, $1,299 | apple.com/au

Apple iPad Air

Style, strong features and fantastic performance at a price you might actually be able to afford.

Apple's fifth-generation iPad Air comes at a steep premium over the base 10th-gen iPad, but it's hard to grumble when it has so many of the strengths of the iPad Pro. These include best-in-class performance and a range of accessories that can transform it into a mobile powerhouse. The IPS screen isn't as stunning as the Pro's Liquid Retina XDR display, but it's still one of the best you'll find.

There's little difference between the 10th-gen iPad and the Air in terms of the design. Both have 10.9in screens with slender frames, a Touch ID button on the top (in portrait mode) and volume buttons on the right.

The iPad Air's screen is laminated, improving contrast and making it feel solid when you tap. The resolution is the same, as is the 500cd/m2 brightness in the specs, but in practice the iPad Air offers slightly higher coverage of both the sRGB and DCI-P3 colour gamuts, while also having darker blacks. Colour reproduction is excellent on both, however, and there's not a night and day difference, side by side.

Connectivity is another matter. Where the iPad has a straight USB-C connector for charging, the iPad Air's is more versatile, supporting 4K and 6K HDR displays at up to 60fps, along with data transfer speeds of up to 10Gbits/sec. What's more, only the Air and Pro support the Stage Manager UI that makes working on external displays so much more productive, with windows-based multitasking and a proper desktop view.

This also makes the iPad Air a better bet if you're prepared to splash out £319 on the Magic Keyboard, with its ingenious hinged, magnetic rear holding the Air's screen just over the top row of keys. It's still one of the few tablet keyboards that can take professional use, with a less cramped layout than the iPad's Magic Folio keyboard and a slightly clickier action. Clamp it on, and the iPad Air becomes a thoroughly workable laptop replacement, with the performance to match.

Sure, the iPad Air isn't as fast as the iPad Pro, but it's speedier than its Android rivals, and the Air will handle all the iPad's creative and productivity apps, and even double as a console if you plan to run games. Both are excellent tablets, and the Air is going to be overkill for less ambitious, casual users. But if you're looking for a tablet that can tackle just about anything, the iPad Air is still worth the extra.

VERDICT

★★★★☆

128GB, $899 | store.google.com

Google Pixel Tablet

A beautifully designed tablet for home users, but not ideal for more serious workloads .

Google's premium tablet takes a different tack to Apple, Samsung and Lenovo, focusing less on mobile productivity, creativity and entertainment, and more on life at home. There's no keyboard or stylus accessory for this one. Instead Google bundles in a speaker dock that charges up the tablet while it's not in use. With its rounded contours, clamped magnetically to the dock at a slight upward angle, it resembles an over-sized smart display.

This is a good thing providing you want to use the Pixel Tablet for the stuff it's best at. It's a great entertainer, for example, particularly as the speaker dock adds a warmth and power to the sound that can't be replicated by a normal tablet – even if the iPad Pro makes a pretty good case. The Pixel Tablet is about as good for background music as you're going to get without a separate streaming speaker system.

Google's slate also makes sense as a central hub for any Google Home devices, and one of the best ways to showcase photos in the home, with the added convenience that you can edit them in situ using Google Photos. You can even remove unwanted objects (or people) from your shots using the Magic Eraser tool.

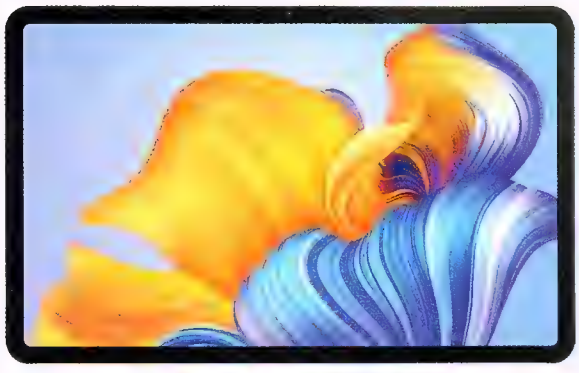
The screen is good, if not in the same league as the iPad Air, Galaxy Tab S9 or OnePlus Pad. We measured brightness levels of 453cd/m2, while it covers close to 99% of the sRGB gamut and 78% of DCI-P3. Watch HDR movies and the 11in, 2,560 x 1,600 resolution display gives you plenty of detail and natural colours. Just without the pop of pricier OLED screens.

Meanwhile, Google's Tensor 2 processor has the performance to run a wide range of apps, performing solidly across our benchmarks, and delivering good frame rates in our 3D graphics tests. Battery life is more than adequate, reaching 13hrs 46mins in our rundown test.

This is a great tablet, then, for use around the home, but is it as versatile as the OnePlus Pad, iPad Air or Galaxy Tab S9? We're not so sure. Though the interface allows for widgets and split-screen views, it doesn't really work for productivity, even with the optional folio case with its adjustable stand. It's good value, and perfect for sofa surfing and Netflix binges, but it's more of a smart home hub and entertainer than a serious all-rounder.

VERDICT

★★★★☆



128GB, $400 | aliexpress.com

Honor Pad 8

A decent budget big-screen tablet that's well built, slim and lightweight, but it's not without some minor flaws.

For a budget tablet, the Honor Pad 8 comes with some big ambitions. For a start, its all-aluminium unibody construction looks and feels as if it belongs to a more expensive model. Just 7.9mm thick and weighing a mere 520g, it's also very easy in the hands. It packs in an unusually large 12in screen, and while it doesn't have the kind of resolution you'll find on the Samsung Galaxy Tab 9 or Lenovo P12, a pixel density of 194ppi still looks relatively crisp. The Pad 8 proves that you can have a big-screen tablet at an entry-level price.

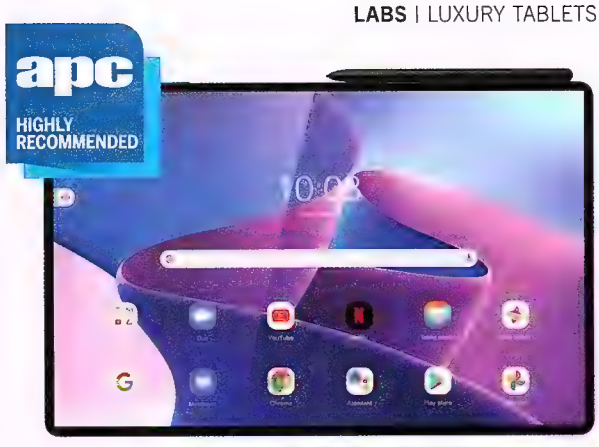
What's more, that screen isn't bad at all. We measured the maximum brightness at 406cd/m2 and strong contrast levels of 1,651:1. It covers a credible 97% of the sRGB colour gamut and 72% of DCI-P3, and colour accuracy is respectable, with a Delta E of 1.51. Even the audio isn't bad at lower volumes, with eight cavity speakers hidden in the body dishing out a spacious sound with a hint of bass, though it soon gets harsh and trebly as you turn the volume up.

The Pad 8 runs Honor's Magic UI 6 software, a rejigged Android 12 with a floating dock at the bottom of the screen and a series of homescreens to host your apps. It's not the most stylish or elegant UI, but it supports a basic form of multitasking complete with split-screen views and floating windows, and while these are initially set up to run Honor's own Email, Files and Gallery apps, it's easy enough to add Google's or a third party's if you – quite rightly – prefer the stock Android apps.

Connectivity is basic, with a USB-C 2 port for charging and an SD card slot, and this is one of the few tablets on test with Wi-Fi 5 connectivity rather than Wi-Fi 6 or 6E. But the real proof that this is a budget option is performance, with the Pad 8 struggling to keep up with pricier Android tablets across the board. It falls far behind in 3D graphics, with doddery frame rates in the basic Wildlife test.

You won't notice this while running basic productivity apps, browsing or checking your email, where the Pad 8 feels reasonably slick, but it only makes sense as a cheap device for consuming content, particularly with the big screen. If you're looking for something with more potential, you'll need to spend more.

VERDICT



128GB, $1,299 | samsung.com

Samsung Galaxy Tab S9

All the power of the Tab S9 Ultra but with a more manageable size and price tag

The Samsung Galaxy Tab S9 Ultra is one incredibly powerful tablet, but with its 14.6in screen and corresponding size, it isn't for everyone. The Tab S9 is a more mainstream proposition, partly because its 11in size is closer to what most people expect from a tablet, and partly because, with prices starting from $1,299, it's more affordable.

You still get nearly the power of the S9 Ultra, as the Tab S9 features the same Qualcomm Snapdragon 8 Gen 2 processor, though with 8GB rather than 12GB of RAM. In our benchmarks, this didn't make a huge amount of difference. Both tablets are prodigiously powerful, and it's only when working on 4K video files in Adobe Premiere Rush that we spotted any vaguely significant speed difference. In fact, the Tab S9 achieved slightly faster results in 3D graphics tests, making it one of the best options out there for mobile Android gaming.

The AMOLED screen might be smaller than the S9 Ultra's, but it doesn't lose anything in terms of quality. It can't quite reach the eye-searing levels of brightness as the iPad Pro or Lenovo Tab Extreme – SDR brightness levels are around 582cd/m2, with HDR content going slightly higher – but it's excellent for video streaming, particularly with 4K HDR content, and colour accuracy is easily good enough for image-editing purposes.

The AKG-designed audio system doesn't let the side down, either, coping well with bass-heavy tracks and soundtracks. If you need to use a tablet for video chats and meetings, you'll be glad to know that both the front and rear cameras can capture high-quality stills and video, complete with clear sound.

While its battery is smaller than the S9 Ultra's, longevity isn't an issue; the Tab S9 will happily get through 13 hours of video playback, not to mention a full day of use. And when you need to top it up, a 45W charger will get it back to nearly 49% in half an hour. Not that one is included in the box.

Price is the Tab S9's biggest problem. It looks and feels every inch a premium tablet, and the bundled S-Pen works a treat for sketches, doodles, precision image editing and handwritten notes. Yet it costs a lot more than the OnePlus Pad, not to mention the base-level iPad. It competes with the iPad Air and delivers a similar experience, but Apple still has the advantage when it comes to apps.

VERDICT

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TCL NXTpaper 11

A fascinating tablet/e-reader hybrid, hampered by slow speeds – but that's reflected in its low price.

All credit to TCL. While other manufacturers are pushing out endless tablets that stick to similar designs, it's gone for something a little more innovative. The clue is in the name. TCL's NXTpaper 2 technology is designed to give you a display that looks and feels less like a super-bright, glossy tablet screen and more like a full-colour e-paper effort.

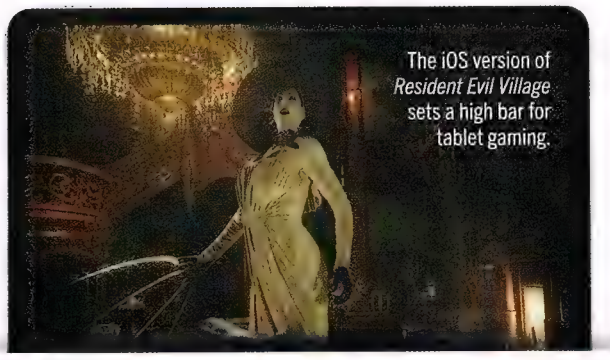
With its narrow bezels, matte finish and minimalist aluminium shell, the NXTpaper 11 will never be mistaken for your average Android slate. Thankfully, at just 462g and 6.9mm thick, it's very comfortable to hold.

The screen works a treat for reading ebooks, digital magazines and comics. It's easy on the eye like an ebook reader, but with the kind of brightness and colour you'd expect from a tablet. Yet whack the brightness up to the maximum 407cd/m2 and you can still have fun streaming video, browsing the web and running apps. In fact, the matte surface on the screen makes it a better bet for use outdoors. Nor is the colour reproduction to be sniffed at, with 94% of the sRGB gamut and 78% of DCI-P3. However, blacks never look really black and contrast also suffers, so be aware that some compromises are involved.

There are some further compromises on features. Wireless networking is stuck at Wi-Fi 5, the USB-C port only supports USB 2. Then there's TCL's own UI on top of Android 13. It's a fairly basic effort with several homescreens to host your apps and no support for floating windows or split screens. At least the audio is clear, with a spacious stereo effect, though it's slightly tinny.

But the biggest issue with this tablet is performance. With its eight-core MediaTek Helio P60T processor and 4GB of RAM, the NXTpaper 11 was the slowest tablet on test in most of our benchmarks, only pulling ahead of the Honor Pad 8 in the 3D graphics benchmarks because the latter has such a woefully weak GPU. In everyday use, the TCL doesn't feel particularly slow, but it hasn't got the snap and instant response of the speedier Android tablets. Battery life is brilliant – it's the third longest-lasting tablet in the Labs – but how much you like the NXTPaper 11 will depend on how much you value its hybrid style.

VERDICT


The iOS version of *Resident Evil Village* sets a high bar for tablet gaming.

The ultimate games machines?

Apple is leading the way for gaming on tablets, but we can't say the same for Android

Tablets aren't just about mobile productivity or creative apps: they're also becoming impressive games machines. We know there's a lot of excitement about the Steam Deck and similar handheld consoles, but tablets can now provide high levels of CPU and GPU horsepower, along with a bigger screen that's a better fit for more complex UIs. And while you don't have a built-in controller, you can hook up an Xbox controller via Bluetooth, prop your tablet up in a stand or case and have everything you need for gaming on the move.

Everything, that is, except the games – at least if you're running Android. Apple long ago saw the potential of iPad gaming, and has invested heavily in turning Apple Arcade and the App Store into serious destinations for mobile play. From iPad versions of *Civilization VI* and *Divinity: Original Sin 2* to original titles such as *Shinsekai: Into the Depths* and *Fantasian*, Apple has consistently delivered a strong lineup of titles optimised for tablet play.

What's more, the new iOS version of Resident Evil Village proves that, with the right hardware, an iPad can handle ambitious, current-generation console games. The game requires an M1 or M2 chip, but it looks and feels uncannily close to the console version running on an Xbox Series console or PlayStation 5. And this is just the beginning, with iPad versions of the *Resident Evil 4* remake, *Death Stranding* and *Assassin's Creed: Mirage* expected in the next few months.

Where is Android in all of this? Not in such a great state. *Genshin Impact*, *Diablo Immortal*, *Fortnite* and *Call of Duty Mobile* provide console-like experiences on Android tablets, albeit with cash-grabbing microtransactions smuggled in, yet console-grade titles remain a way off. It's hard to know whether this is due to the established unwillingness of Android users to pay up front for software, or to the lack of a standardised hardware. Either way, it's an opportunity being lost.

In fact, the best way to game on Android isn't to play locally, but to stream instead. Install the Xbox Games Pass and GeForce Now apps and you're good to stream from the leading gaming services. Or why not install the Steam Link or Moonlight streaming apps and stream straight from your gaming PC? With Sony's PS Remote Play or the third-party PSPlay app, you can even stream games from your PS 5. You won't end up playing on the move, but at least you can play your favourite games wherever you want at home.

HOW WE TEST

We put our tablets through a barrage of cross-platform benchmarks, starting with Geekbench 6 to test CPU performance. The single-core aspect puts the most powerful core to the test, while the multicore section reveals any weaknesses – while most ARM chips have eight cores, some are much faster than others. Geekbench's Compute section is a synthetic test of the GPU.

For more real-world-style tests, we use a selection of browser-based benchmarks. Basemark Web 3 and WebXprt 4 use a similar approach, with tasks such as photo enhancement, productivity and GPU acceleration. JetStream 2 gives a good indication of how tablets will cope with complex JavaScript and apps based on WebAssembly. And Kraken is an out-and-out JavaScript benchmark.

We also use 3DMark and GFXBench to torture-test the graphics chips. 3DMark's Wild Life test takes advantage of more advanced features, while the GFX benchmarks are more basic. Note that the offscreen test gives a better indication of raw speed, as it won't be affected by refresh rates or higher resolutions.

Our screen tests cover colour coverage, accuracy (Delta E), brightness and contrast (although OLED screens are effectively perfect). In the crucial DCI-P3 space, favoured by film-makers, we print both gamut coverage and volume. If the latter figure is above 100%, it means it stretches even further than that rich colour space.

Finally, our battery rundown test repeatedly plays a 1080p video file with the brightness of the displays set to 170cd/m2. We then measure how much they recharge to after 30 minutes.

We also used each tablet for a mix of web browsing, video streaming, office work and gaming, to see how they measure up in real-world use.

BENCHMARK RESULTS SPEED TESTS	Geekbench 6 - single core	Geekbench 6 - multi core	Geekbench 6 - compute
Amazon Fire Max 11	932	2,253	1,037
Apple iPad (10th generation)	2,070	4,856	16,468
Apple iPad Air (5th generation)	2,400	8,704	32,503
Apple iPad Pro 12.9 (6th generation)	2,641	9,926	46,046
Google Pixel Tablet	1,449	3,788	4,106
Honor Pad 8	412	1,434	347
Lenovo Tab P12	969	2,266	2,377
OnePlus Pad	894	3,105	6,109
Samsung Galaxy Tab S9	2,116	5,695	9,608
Samsung Galaxy Tab S9 Ultra	2,115	5,560	9,585
TCL NXTpaper 11	308	1,233	1,118

BENCHMARK RESULTS SPEED TESTS	JetStream 2	Basemark Web 3	Kraken 1.1
Amazon Fire Max 11	67	240	2,161
Apple iPad (10th generation)	186	1,279	540
Apple iPad Air (5th generation)	250	1,444	481
Apple iPad Pro 12.9 (6th generation)	246	1,880	448
Google Pixel Tablet	103	553	996
Honor Pad 8	53	243	2,667
Lenovo Tab P12	65	345	2,187
OnePlus Pad	61	492	1,964
Samsung Galaxy Tab S9	202	904	720
Samsung Galaxy Tab S9 Ultra	199	1,046	669
TCL NXTpaper 11	35	207	3,916

BENCHMARK RESULTS 3D TESTS	3DMark Wild Life Extreme	GFXBench Car Chase - (on-screen)	GFXBench Car Chase - (Normal 1080p offscreen)
Amazon Fire Max 11	319	13	14
Apple iPad (10th generation)	2,155	39	74
Apple iPad Air (5th generation)	4,433	60	138
Apple iPad Pro 12.9 (6th generation)	6,235	75	198
Google Pixel Tablet	1,879	39	67
Honor Pad 8	123	7	8
Lenovo Tab P12	622	10	25
OnePlus Pad	2,368	35	76
Samsung Galaxy Tab S9	3,915	60	121
Samsung Galaxy Tab S9 Ultra	3,845	60	125
TCL NXTpaper 11	187	7	8

BENCHMARK RESULTS SCREEN TESTS	sRGB coverage - %	DCI-P3 coverage - %	DCI-P3 volume - %
Amazon Fire Max 11	95	74	75
Apple iPad (10th generation)	94	68	68
Apple iPad Air (5th generation)	98	73	74
Apple iPad Pro 12.9 (6th generation)	99	79	82
Google Pixel Tablet	99	84	85
Honor Pad 8	97	72	72
Lenovo Tab P12	99	95	97
OnePlus Pad	98	93	97
Samsung Galaxy Tab S9	100	98	131
Samsung Galaxy Tab S9 Ultra	100	98	129
TCL NXTpaper 11	94	78	84

BENCHMARK RESULTS SCREEN TESTS	Average Delta E	Contrast ratio	Peak brightness - SDR cd/m2
Amazon Fire Max 11	2.28	1,560	499
Apple iPad (10th generation)	0.78	1,026	417
Apple iPad Air (5th generation)	0.7	1,240	415
Apple iPad Pro 12.9 (6th generation)	0.24	2,000	591
Google Pixel Tablet	2.51	1,841	453
Honor Pad 8	1.51	1,651	406
Lenovo Tab P12	1.04	1,668	434
OnePlus Pad	3.71	1,451	528
Samsung Galaxy Tab S9	0.26	2,000	603
Samsung Galaxy Tab S9 Ultra	0.18	2,000	765
TCL NXTpaper 11	4.65	1,294	407

BENCHMARK RESULTS BATTERY TESTS	Rundown tests - hrs:mins	Recharge time after 30mins - %
Amazon Fire Max 11	19.21	16
Apple iPad (10th generation)	11.56	36
Apple iPad Air (5th generation)	11.2	34
Apple iPad Pro 12.9 (6th generation)	11.55	34
Google Pixel Tablet	13.46	24
Honor Pad 8	14.51	19
Lenovo Tab P12	11.2	18
OnePlus Pad	17.16	18
Samsung Galaxy Tab S9	13.2	49
Samsung Galaxy Tab S9 Ultra	13	28
TCL NXTpaper 11	17.3	23

VIEW FROM THE LABS

A SLEEK, SHINY BODY SIMPLY ISN'T ENOUGH.

If there's one takeaway from this month's Labs, it's that even as the tablet hardware gets better it's increasingly the ecosystem that makes the most tangible difference.

When I started reviewing tablets around 12 years ago, there was a huge gulf in quality between Apple's hardware and everybody else's. The Android competition was heavier, uglier and slower, with woeful low-resolution screens and limited processing power the norm. That's no longer true. Metallic shells and unibody constructions are standard, and it's rare to find anything without a decent screen.

There's good news on the software front as well. With a little help from Google, more Android manufacturers provide proper split-screen and floating window support, and UIs built with tablets in mind. It's still frustrating to see so many iPad apps unavailable on Android, but there are enough creative and productivity apps to meet most requirements.

Yet it's the ecosystem that really matters: having the hardware, software, peripherals and services in place to make a tablet a serious business or creative tool. Apple and Samsung lead the way with their keyboard and stylus options, and Lenovo isn't far behind. Amazon is heading in the right direction, but FireOS doesn't feel primed for productivity or art, while its app store still lacks key apps.

Of the others, it's newcomer OnePlus that seems to best understand that just having a big screen and a keyboard case available doesn't cut it; you need a UI that's flexible enough to support real multitasking, and access to the apps and services you need to get to work. That's worth paying the extra for, and it's also what keeps Apple and Samsung at the very top. ■

Part 4: Welcome to Television

A Vision to Behold: The Story of Electronic Displays

A cathode-ray tube looks like a funnel with electrons firing from the slim 'neck' towards the phosphor-coated front screen (Image credit: Raimond Spekking, CC BY-SA 4.0).

The 1950s/60s were contrasting decades, yet free of world war, they gave television a clean run, plus the invention of a light xsource that continues to shape our world today. Darren Yates writes.

It's now 1950 and Australia still doesn't have TV. Despite public demonstrations the year before giving huge crowds a taste of the future, it would take the combined weight of a royal commission and Australia's first Olympics to finally get the first stations on the air from September 1956. Yet over the next two decades, the world would not only see television in colour, it would end the '60s with ground-breaking vision of humans landing on the moon. Even more astoundingly, the 1960s would provide us an early glimpse of technologies that continue to drive electronic displays today.

Better late than never...

In 1949, then-prime minister Ben Chifley had hoped to seal a federal election win for the Australian Labor Party by announcing plans for a national television service. It wasn't enough and Robert Menzies was elected to begin his second stint as Prime Minister. Menzies' eventual response to the ever-growing calls to introduce television came in February 1953, with the launch of 'CA 2641, Royal Commission on Television'. A year-long investigation into the introduction of television in Australia, it considered everything from the technical issues to the social impact of its arrival.

The end result was that there would be no mad-panic rush to launch stations, but rather an orderly beginning, with the *ABC* plus two commercial station licenses awarded in Sydney and Melbourne (prior to 1974, you required a licence to listen to the radio in Australia, but it was decided that the *ABC*'s television bill would be covered by the existing fees paid by radio listeners).

CCIR System B

If there's an upside to being late to the TV party, it's that we had the pick of TV standards to choose from. The U.K.'s 405-line system had been operating since before the war, while the U.S. 525-line system wasn't really an option (in short, analog TV had to be referenced to the mains-power frequency – the U.S. power frequency is 60Hz, but Australia's is 50Hz. We couldn't use the U.S. system without the frequency mismatch causing interference on our screens). France had the highest-resolution TV with 819 lines, but with few countries adopting it, costs would've been considerably higher.

In the end, Australia settled on the Comite Consultatif International des Radio-communications (CCIR) recommendation of Europe's 625-line standard (today, the CCIR is known as the 'International Telecommunications Union Radio-communication sector' or ITU-R).

More specifically, the 'CCIR System B' standard delivered 625 TV lines (576 visible lines and 49 'blanking' lines) at 25 frames per second. To reduce flicker at that low frame rate, each frame was split into two half-frames or 'fields' appearing at 50 fields per second and each field alternately consisted of 312.5 'odd' or 'even' lines. The video had 5MHz of bandwidth, with the single-channel audio transmitted at 5.5MHz above the designated channel frequency.

CCIR-B came out of post-war Europe through the combined engineering skill

" To ensure the electron beams hit the right phosphor, behind the front phosphor layer was a masking layer consisting of a series of holes called a 'shadow mask'."

1 The first OB (outside-broadcast) van used by ABC Sydney station, ABN2 (Image credit: National Museum of Australia, CC BY-SA 4.0).
2 The helical-scan rotary head enabled video recorders to capture high bandwidth with slow tape speeds (Image credit: Atlant, CC-BY 2.5).
3 The first light-emitting diodes were used as status indicators, replacing small light globes (Public Domain).
4 RCA Labs electrical engineer George Heilmeier was a pioneer of liquid crystal display technology (Image credit: IEEE, CC-BY-SA 3.0).

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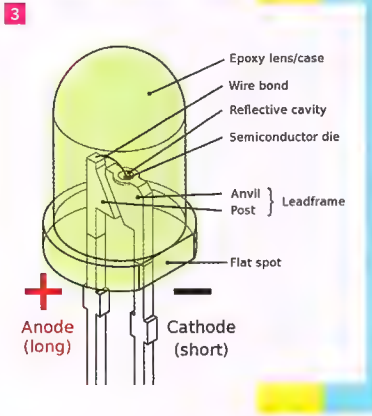

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of Russia and Germany. Leading the team was Walter Bruch, an electrical engineer at tech giant Telefunken. In 1962, Bruch invented the 'Phase Alternating by Line' (PAL) colour TV standard Australia later adopted in 1974.

B&W TV sharper than colour

CCIR-B mightn't have had the highest resolution going around, but, contrary to a number of reports online, the image quality of 1950s/60s Australian black-and-white (B&W) TV was actually exceptionally good – and sharper than colour TV when it arrived in Australia in 1975.

The 5MHz bandwidth of Australian TV broadcasts in 1956 was amongst the highest in the world. But to ensure B&W TVs continued to work after the introduction of colour television required incredible engineering skill on the video signal itself. This was achieved by cleverly attaching the colour or 'chrominance' information to the B&W ('luminance') video signal via a colour frequency or 'subcarrier'. The frequency of this subcarrier was also chosen carefully (a precise 4.43361875MHz) so as to minimise interference on existing B&W TVs. Essentially, B&W TVs just ignored it, but colour models picked it up.

Nevertheless, there was another difference – the cathode-ray tube (CRT) in a B&W TV didn't actually have discrete pixels. Instead, the screen featured a very fine chemical phosphor layer and when the very narrow electron beam hit the phosphor at a particular point, it glowed, giving the appearance of a dot. However, the beam was continuous and as it drew each horizontal line that made up the image, you saw the complete bandwidth of that image. That made B&W TV exceptionally sharp.

Colour TV was different – there were now three electron beams and the phosphor layer consisted of the three primary colours, red, green and blue. To ensure the electron beams hit the right phosphor, behind the front phosphor layer was a masking layer consisting of a series of holes called a 'shadow mask'. The effect of the shadow mask holes meant you only saw a more limited bandwidth.

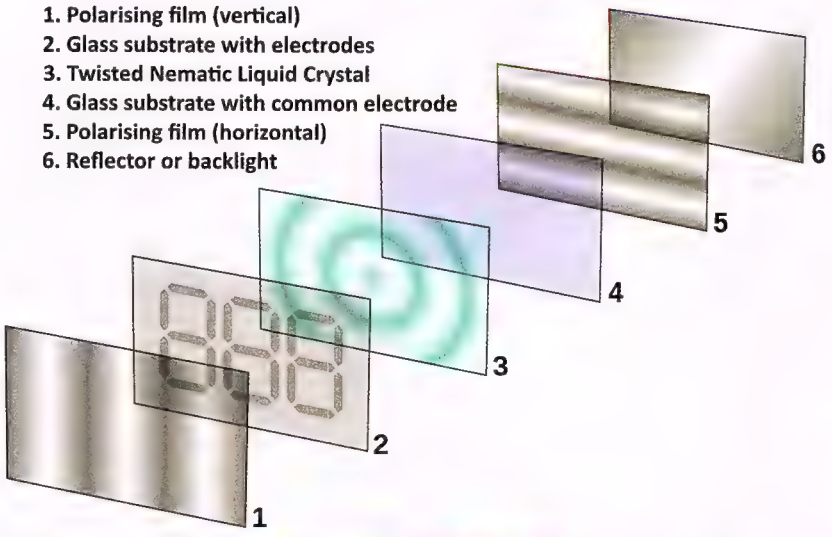
So while we got colour in 1975, the combination of modified video signal and new CRT design meant it was difficult for colour TV to achieve the same image sharpness as B&W TVs before 1975.

Nevertheless, Australia now had TV just in time for the Olympic Games in Melbourne. Moreover, the CCIR standard proved so good that analog TV broadcasts (and later in their colour PAL form) would continue for 57 years, not ending until December 2013 (**www.youtube.com/watch?v=cT6iJ9FT1nO**).

Can we record video?

Meanwhile, it became the invention as important to television as television itself. Until 1952, TV broadcasts were invariably 'live', with live-action actors in real-time. Popular crooner and movie star Bing Crosby had revolutionised the radio industry, funding development of broadcast-quality audio tape recorders in 1947. As a result, he was now free to pre-record his broadcasts at a time of his choosing, not the network's broadcast schedule – and at first, audiences didn't actually realise they weren't listening to Crosby live.

In 1951, Crosby wondered aloud if the



1 The first liquid-crystal displays appeared in watches and calculators, consisting of multiple electrode and glass layers (Image credit: Ed g2s, CC BY-SA 3.0).
2 Ampex VR-1000 video tape recorders were used in ABC's Sydney (Gore Hill) studios during the early 1960s (Image credit: Karl Baron, CC BY 2.0).
3 The kinescope was the first TV recorder, capturing a precise TV image to film (Public Domain).
4 The transmission tower on Hampden Rd, Artarmon now transmits broadcasts for all three Sydney commercial TV stations, ATN7, TCN9 and TEN10 (Image credit: Sardaka, CC-BY 3.0).
5 Plasma TVs feature cells where electrified gas gives off electrons that collide and produce light. (Image credit: Jari Laamanen, FAL).

same could be done for TV. However, the major problem was that while audio required a bandwidth of just 20kHz, even average-quality video would require capturing a frequency bandwidth in excess of 100 times that.

The first tests attempted to use recorders with a fixed-position recording sensor or 'head', similar to recording method used in audio cassette recorders. Engineers knew that if they could speed up the tape across the head, the bandwidth would improve. However, despite a tape speed of 100 inches per second (over 9km/h), they could barely achieve 1MHz bandwidth and the results were awful.

The problem required a radical rethink and examining the path of the tape across the head. The solution wasn't speeding up the tape further, but speeding up the head. A number of different systems were tried, but the first commercially-sold video tape recorder featured four recording heads mounted on a rotating disc that spun across the two-inch (five-centimetre) wide tape in excess of 2,000 RPM. It produced a recorded video bandwidth of over 7MHz, but with a tape speed of just 15 inches per second (38.1 centimetres).

The Ampex VR-1000 as it was known became a staple in TV studios around the world, including in the Gore Hill studios of Sydney's ABC station ABN2 at least into the early-1960s. Speaking with a former *ABC* broadcast engineer who worked with these recorders, they were noisy machines, with the multiple heads often catching the tape edge causing the machine to emit a noticeable whine.

By 1961, this 'transverse-scanning' head technology had given way to new 'helical scan' heads. Here, the tape wrapped around a metal cylinder or 'drum' while multiple offset recording heads scanned the tape in a diagonal path. This allowed the machines for the first time to pause the tape and still produce a clear still image.

"Technology is rarely conceptualised and perfected in the same year, but 1964 proved to be a pivotal year that further inspired next-generation developments that still power our world today."

Television on repeat

It was during this era that words such as 're-runs' and 'repeats' entered our dictionaries. The first recording machines used by TV stations were called 'kinescopes' (or 'telerecordings' in Australia), which recorded a synchronised TV screen directly to film. Copies of the film could then be sent to other stations, which was initially how TV shows were distributed. However, as video tape recorders became increasingly popular, distribution shifted from film to tape, before satellite transfer eventually took over.

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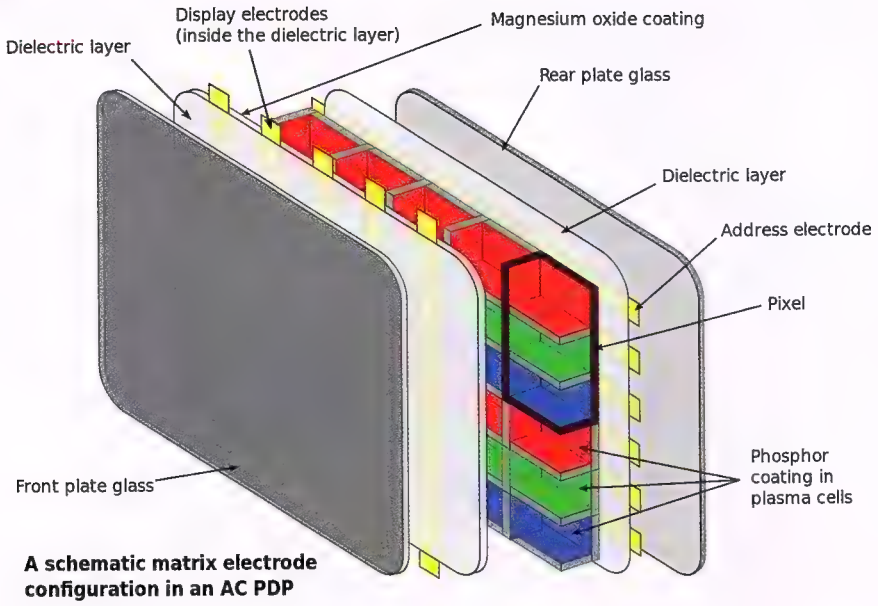


A schematic matrix electrode configuration in an AC PDP

In 1958, America's NBC network recorded the first colour TV broadcast at its new facility in Washington of U.S. president and WWII general Dwight D. Eisenhower. The broadcast survives today as the oldest colour video recording (**https://www.youtube.com/watch?v=4vBEMGTdDYc&t=911**).

Beyond the cathode-ray tube

To this point, television had been driven by the cathode-ray tube (CRT), but the CRT had its limitations, not least of which was its fragility. A CRT, top-down, looks like a funnel – a wide front-face angling back to a long narrow centre tube or 'neck'. Being all-glass, the CRT wasn't portable, nor was it rugged. Second, as demand for larger screens grew, so too did the size of the tube itself. Engineers did their best with innovations such as the short-neck CRT, but the very nature of how a CRT works was a limiting factor. A TV tube starts with one or more electron 'guns' in the central 'neck' area of the CRT firing elections towards the front phosphor screen you look at. But to reach all corners of the screen, the electrons have to be angled or 'deflected' from the centre neck axis to the outer edge. By the 1950s, the maximum 'deflection angle' was 90-degrees and during the 1960s, it pushed out to 110-degrees. However, it meant that the wider the screen front of the tube, the deeper the tube itself had to be to handle the maximum deflection angle. Bigger CRTs also weighed more and required more structural support in the TV housing. For the most part, CRTs survived as the primary lounge room display well into the 1990s. However, if ever a year showed the future beyond the CRT, it was 1964.

Liquid of crystals and cells of gas

Technology is rarely conceptualised and perfected in the same year, but 1964 proved to be a pivotal year that further inspired next-generation developments that still power our world today.

The phenomena of 'liquid crystal' was discovered (and subsequently named) by an Austrian botanist, Friedrich Reinitzer, in 1888. He'd discovered a substance, later called 'Cholesteryl Benzoate', that melted into a cloudy liquid at 145°C and acted like a crystal, splitting a ray of light into two separate paths. But on reaching 179°C, the substance change state again and became a clear liquid.

For the next 70 years, liquid crystals remained little more than a curiosity until Richard Williams, an engineer at RCA Labs discovered in 1962 that he could manipulate the transmission of light by electronically controlling the liquid crystals. Williams and RCA soon patented their results.

However, it was engineer George Heilmeier who, in 1964, took things a step further and developed the first dynamic-scattering mode (DSM) LCDs. In 1967, Heilmeier presented a new glass display to his boss, Richard Klein and his boss, Lawrence Murray.

It looked like a straight piece of transparent glass – that is, until Heilmeier flicked the power switch and up came a clearly visible black-and-white TV test pattern image. Klein later recounted that he nearly fell over in amazement.

The first computer graphics screen

However, while Heilmeier began seeing results with liquid crystals, staff at the University of Illinois were attaching a new display to the university's computer system dubbed 'Project Plato'. By the mid-1960s, universities continued to be the most likely places you'd run into a computer and Project Plato was used as a teaching platform. However, computer graphics weren't a thing in 1964, nevertheless, this new display could do things not before seen.

The display was created by Prof. Don Bitzer, Prof. Gene Slottow and graduate student Robert Wilson. The unique construction featured cells of Neon gas that when electrically excited by a voltage, caused electrons to free from the Neon atoms. The collision of those electrons together created light and from the outside, that light appeared with a unique orange glow. Moreover, the new 'plasma display panel' featured built-in memory that allowed it to store an image through individually-addressable pixels.

The Light-Emitting Diode

Apart from the moon landing, the 1960s rounded out with an invention that still commands display technology today. While the first practical light-emitting diodes appeared in 1962, their prices were reportedly in the order of AUD$300 each. It wasn't until 1968 that component manufacturer Fairchild managed to get mass-production costs down to just 10 cents per unit that they began taking over the electronics industry.

LEDs were originally manufactured in metal casings before low-cost plastic 3mm and 5mm LEDs arrived during the 1970s. They replaced comparatively power-hungry 'grain-of-wheat' light bulbs in electrical meters and old radios, as well as acted as status indicators in test equipment – even appearing in watches. For their size, those original LEDs also weren't very bright and it took many years for their size to shrink and their brightness to reach the stellar levels of today's models.

However, one thing was true of all of these inventions – it would still take many years before they'd own the lounge-room. ■

Next time

Next time, we swing by the 1970s – we look at how colour TV changed Australia and how a slew of revolutionary new gadgets transformed the television into a new technology hub. *See you then.*

© Apogee Entertainment / Ken Rieger

Mail trucks and millions of dollars

How **shareware** transformed **PC gaming** forever

We can thank floppy disks in Ziploc bags for the FPS genre as we know it.

The year is 1982. The internet won't exist for several months yet, and the Web won't go World Wide for another decade. But if you send a formatted floppy disk to a man named Andrew Fluegelman, he'll pop a copy of his communications program PC-Talk on it and send it back free of charge. If you like it, you can make further copies for your friends. In the event you really like it, you can send Fluegelman $25. "If you order the program and are disappointed," wrote PC Mag in its August-October 1982 issue, "you've lost nothing but a stamped, self-addressed envelope."

Fluegelman characterised this model as "an experiment in economics more than altruism", and sure enough, it soon started making people rich. Free distribution gave software developers such enormous reach long before internet downloads that even voluntary payments from a fraction of their users resulted in huge profits. They settled on a name: shareware.

Apogee founder Scott Miller grew up in a household with a former NASA engineer for a dad and an IBM PC packed with shareware. "My father had even sent a couple of guys some money," he says. "So it was on my mind." By the mid-80s, the younger Miller was coding videogames in his spare time at college and making them available much the way Fluegelman had.

"I had written some text adventure games in the style of Infocom, released those into shareware and asked people to send me money," he says. "And it just was not working out at all. I wasn't making anything."

The money model

What Miller was missing was an enticement – a way to lure players into payment, without giving away a whole product. In 1987 he put out a trilogy of fantasy roguelikes named *Kroz: The First*, a 25-level game, was released for free, but the second and third parts cost $15 each. "That was the magic trick that worked," he says. "No one else was doing that. I immediately wrote another three *Kroz* games and did the same thing with those."

By the end of the decade, Miller was making $100,000 a year through cheques showing up in his mailbox. He quit his day job and began reaching out to other game authors through pre-internet services like BBSes and CompuServe. One was Todd Replogle, an "amazing, amazing talent" who dreamed up *Duke Nukem* with Miller and worked as a programmer on the series from its origin as a platformer through to its final, 3D form.

Another was John Romero. At the time, Romero and the team that would become id Software were pumping out a new game every month for Softdisk, a company that promised subscribers 12 original games over the course of a year for a total of $89.95.

John Carmack had blown Miller away with his demo of a smooth-scrolling platformer on the PC – a feat akin to distilling *Super Mario* in his garage (id literally did that, too). But the nascent id Software wasn't convinced of the merits of shareware. "If you want us to make a game for you," they told Miller, "you gotta pay us $2,000 to do it." Miller practically punched the air, knowing he would have gladly paid 10 times that amount to publish id's first game.

Keen dreams

In December of 1990, Miller uploaded *Commander Keen*'s first episode to bulletin board systems that served as file sharing hosts. For $30, players could order the two follow-up episodes on floppy disks in Ziploc bags. And they did. In droves. By the end of the month, Miller had sent Romero and co. $10,000 in royalties.

The next cheque, in January, was for $25,000. "It just grew from there," Miller says. "At that point, they were completely sold on the whole idea of shareware."

1 Scott Miller 2 Carmack and Romero 3 *Rise of the Triad* 4 Shareware advertising back in the day 5 *Quake* was an iconic legend even at the beginning of it all 6 *Wolfenstein 3D* blew open the doors to shareware success.

Yet shareware wasn't solely a pact between the publisher, developer and consumer. It required the cooperation of the postal service, which was completely fascinated by this new mail phenomenon – taken to a new level by the launch of *Wolfenstein 3D*. "They actually sent an empty truck to our office, just to load up all the packages and everything we were sending out," Miller says. "We got really close to them, and also developed a really good relationship with our local printer for all the labels and everything. Early on, Apogee developed more as an order-taking company."

Only in the months after *Wolfenstein 3D*, as id Software's star continued to rise, did Apogee move into internal development. While the company was still working with several shareware creators, Miller knew that Romero and Carmack would want to break off on their own, and so asked former id Software designer Tom Hall to lead work on *Rise of the Triad*, a new Apogee FPS that would keep the company's mail order staff and infrastructure busy, and the money flowing in for what seemed like a sure-fire success.

"It actually started off as a *Wolfenstein* sequel," Miller says. "*Wolfenstein 3D: Rise of the Triad*. That's why it has the whole military angle. But about 10 months into development we got a call from John Romero, who said, 'You know, we really don't want another *Wolfenstein* game coming out. We'll let you continue to use the engine, but you can't call it *Wolfenstein* anymore.'

"Their worry was that it was going to be released too close to their coming game, *Doom*, and they didn't want the competition."

Doom ended up sweeping away any and all competition. Shareware players bought 1,154,541 copies, placing it among the best-selling games of the '90s. In the process, *Doom* brought shareware to the attention of an enormous audience, and inextricably associated the model with the budding FPS genre. By then shooters were becoming too large and complicated to be developed as trilogies like *Kroz* and *Commander Keen*, so the convention was to release a generous set of taster levels for free. If players wanted more, they could mail in for the rest.

Shadow war

Shareware's sales structure couldn't help but have an impact on the shape of a game itself, tempting developers to stick the finest levels upfront to make the best possible impression. At Apogee, though, development tended not to pan out that way. "We gave a lot of thought to maybe developing the middle episode first," Miller says. "And once we become experts in making our own game, then we can do the first episode, make sure we get it right. But it never worked out, we always made the first episode first. For a lot of our games, the later episodes were the better ones because of that."

Of course, many players never saw those later, more refined episodes. For Rocksteady web developer Jason Burt-D'Arcy, who was a young teen living in the small Southampton suburb of Netley Abbey in 1994, access to free games was a revelation. *Wolfenstein*, *Doom*, *Heretic*, *Duke Nukem 3D*, *Shadow Warrior*, *Rise of the Triad*, *Descent*, *Quake* – he played them all. Up until they asked for a cheque, that is.

"You got some levels, a bunch of weapons and a cool boss to kill at the end,"

© Apogee / Scott Miller, John Romero, Apogee, Epic Games

he says. "Because these games, *Doom* in particular, were so good you would just go again. It had scaling difficulty and loads of hidden things so there was still plenty to do. I never felt like I wanted more because I'd been given so much already."

At the time Miller reckoned that Apogee's games were in some cases reaching tens of millions of people: "My estimate was that about one or two in every 100 people that would download a game would end up sending us money for it," he says. "Nowadays, ordering on Steam is just pressing a button. Back then you had to pick up the phone and have your credit card ready or write a cheque. There was a lot more friction."

There were additional barriers for international players, too. Apogee established a worldwide network of partner distribution companies and published lists of local dealers that could be accessed via the menus of its games. Yet even so, some customers were put off by US-centric advertising in an age when the oceans between continents felt wider. "I remember taking one look at the purchase information and it was 0800 numbers and US dollar pricing," Burt-D'Arcy says. "I wouldn't have known where to start."

Those borders came down with the internet, and by the late '90s shareware had made enormous successes of not just Apogee but other lasting companies like Epic Games. It had shaken the traditional industry to its core. "I remember hearing a story that there was a board meeting at Electronic Arts," Miller says. "And one of the top people slammed *Wolfenstein 3D* on the table and said, 'How are these guys beating us? How can some little company out of nowhere be making better games than us?'"

By 1996, *Quake*'s shareware edition was the sixth-best-selling game of the year in the US.

But in the end, the internet brought down shareware too. Over time it became possible, and then trivial, to download full games online, making mail order the preserve of lavish collector's editions.

Shareware?

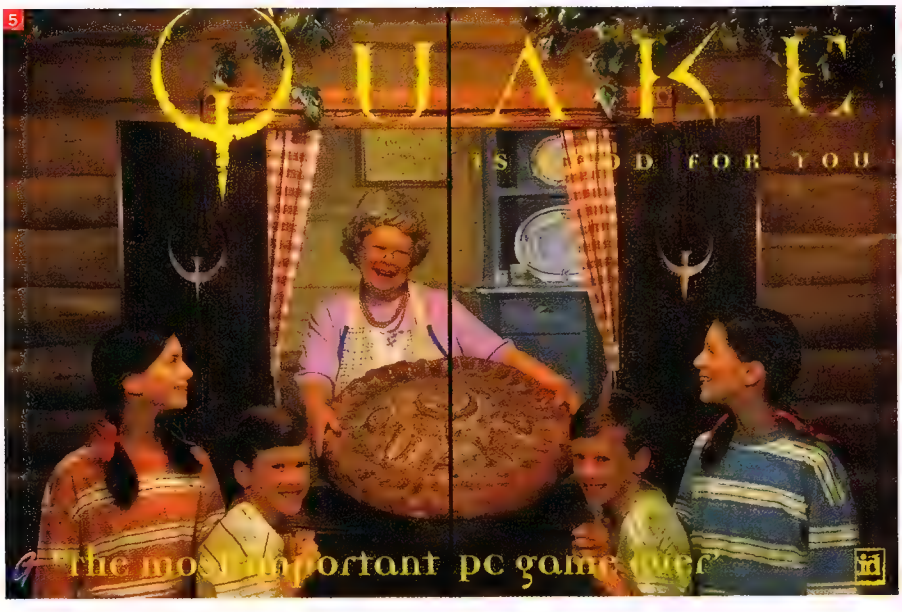
While the idea of episodic gaming still appeals to developers, it's often proven to be a poor fit for the volatile and unpredictable nature of game production. Valve abandoned *Half-Life 2*'s expansion episodes after two entries stretched across multiple years. And although *Hitman*'s *World of Assassination* trilogy is now a huge commercial success, that wasn't true while its first levels were releasing one-by-one – most players prefer to wait for a whole, finished product before investing.

The original Telltale Games remains the biggest name in episodic gaming – yet financial insecurity and the crunch associated with an aggressive release schedule saw the company unravel in sad, spectacular fashion back in 2018.

So where does the spirit of shareware live in PC gaming today? Not with free-to-play, according to Miller. "There's always some sort of grinding element that you can somewhat bypass if you pay, which I'm just not a fan of at all," he says. "We never had anything like that. There were no throttle [points] in the shareware releases of our games."

Miller's more keen on demos, which have seen a re-emergence in recent years thanks to both the rising cost of full-price games and high-profile events like Steam Next Fest. "They're super important for game developers to be doing nowadays," he says. "Even more than early access. Because what you're trying to do with a demo is just get your game out there, allow people to download it for free, and once again get hooked to the point that they wishlist it."

Crucially, demos are a way to spread word-of-mouth without exposing an unfinished game to Steam user reviews. "It's a way to have the public help you playtest, get great feedback from them and modify your game as necessary," Miller says. "At most you want to give away about 25-to-30% as your demo, which is what we did back in the shareware days." It's a model the modern-day Apogee will be following for all its upcoming releases.



As an adult, Burt-D'Arcy works as a web developer, and sees something like a shareware spirit in his field. "The sheer amount of code that is written and given away for free is completely mind blowing," he says. "So much of the systems that run our daily lives is [built] on code that people wrote because they love making things."

Yet in games? "I don't think there is anything really like it anymore," he says. "Shareware was about faith. Faith in your own ability to make something good, and faith in people to respect and respond to that."

It wasn't altruism, as Fluegelman pointed out in the beginning. But it was rooted in something pure – an optimistic belief that generosity would be rewarded in kind. ■ **Jeremy Peel**

© iD Software, Apogee / Scott Miller

RUN WINDOWS ON YOUR APPLE SILICON MAC FOR FREE

Boot Camp may have got the boot, but it's still possible to run Windows applications on macOS. **Darien Graham-Smith** finds out how.

When Apple migrated the Mac platform from Intel CPUs to its own ARM-based chips in 2020, it spelt the end for the Boot Camp utility. Windows simply couldn't boot on the new M1 hardware, so the popular dual-booting tool was quietly ditched.

However, if you still want to run Windows applications on your Mac, there is a way. For more than a decade, Microsoft has been working on bringing Windows to the ARM platform, and its latest releases are now more than mature enough for day-to-day use. If you want to try out some cross-platform action on your own Apple Silicon Mac, you can buy an ARM edition of Windows 11 from the Microsoft online store – or you can download the latest Insider Preview release and run it for free. Here's how.

Expectation management

The great thing about Windows on ARM is that it has a built-in translation layer, which enables it to run existing Intel applications without modification. The ARM version of Windows 10 only works with 32-bit code, but the latest Windows 11 builds support 64-bit software, too, so you can run almost any application on ARM hardware. The main exceptions are programs that try to interface directly with the hardware or install their own system drivers, such as 3D games or third-party security tools – although the built-in Windows Defender is still there to protect you against online attacks.

This translation layer does,

however, incur a certain performance penalty. What's more, since Apple Silicon doesn't support dual booting, Windows has to run inside a virtual machine, which means it can't make full use of your Mac's memory and CPU resources. The upshot is that Windows applications should still be perfectly usable, but they may feel sluggish and jittery compared to the snappy experience you're used to on your Mac.

Finally, bear in mind that Windows Insider builds come with no formal guarantee of stability or support. And while you're not legally obliged to activate your Insider OS, a few desktop customisation features won't be available unless you enter a valid product key.

In all, if you want to run Windows as your primary operating system, you'll probably get a better experience from a real Intel PC. But if you're happy using your Mac for everyday tasks, and just occasionally need to run a few specific programs in Windows, a virtual machine running Insider code could well be all you need.

Getting the Windows installer files

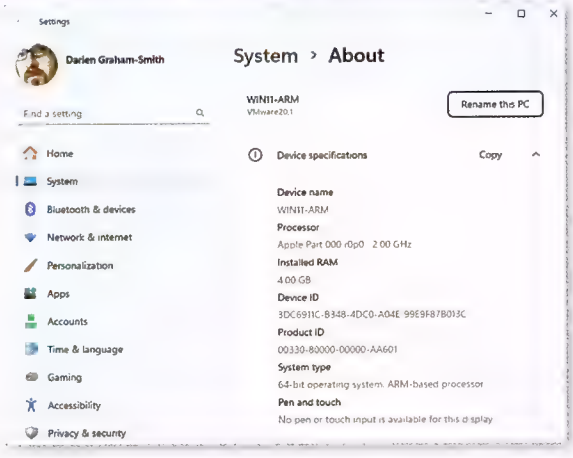
Right now, Microsoft doesn't publicly offer a downloadable installer for the "stable" edition of Windows on ARM, unless you buy it through the online store. However, it's easy to get hold of, as we'll see below. Just remember that it's not legal to use the commercial edition without a licence and product key.

If you prefer to take the free route, you can download the Insider Preview installer directly from Microsoft, as long as you're a member of the Windows Insider Preview programme. If you haven't already joined, you can register online at **www.microsoft.com/en-us/windowsinsider/register**. You can also join via the Settings app on any PC running Windows 10 or 11, but doing it this way will configure that PC to receive pre-release OS updates, which may not be what you want.

Once you've enrolled in the Insider Programme, you can download the Windows 11 installation files for ARM from **tinyurl.com/APC528arm64** (you may need to sign in to your Microsoft account again to confirm your Insider membership). The page will present a drop-down menu offering you three different builds of Windows 11: the Canary and Dev releases give you a chance to try out the very latest code, while the Beta version should be the most stable. After making your choice, hit Confirm.

Next you'll be prompted to choose your language; this isn't a hard decision, as at present the only option is US English. After you've selected this a download link should appear. The Windows 11 installer comes down the line in the form of a large (around 10GB) disc image file in Microsoft's VHDX format.

Having saved this file onto your Mac you can, if you wish, immediately cancel your membership of the Windows Insider Programme. To do so, visit **tinyurl.com/APC528leave** and click "Leave the program now" – or go back to the Windows Insider settings on your PC, scroll down to the bottom and click the "Leave the Insider programme" link.



TOP You can join the Insider programme from within Windows 11. **ABOVE** Windows happily recognises and supports Apple Silicon hardware.

> "If you prefer to take the free route, you can download the Insider Preview installer directly from Microsoft, as long as you're a member of the Windows Insider Preview programme."

Choosing a host and preparing your installation media

MacOS doesn't come with a built-in virtualisation host, but there are plenty of third-party tools to choose from. The slickest is Parallels (parallels.com), which supports some neat features such as running Windows applications directly on the Mac desktop. However, it costs $134,25 for personal use – and that doesn't include a Windows licence.

If you're looking for a free solution, you have a few other options. The open-source UTM hypervisor is one popular choice (mac.getutm.app), but it has limited support for saving and resuming VM snapshots, so it's not ideal for quickly firing up Windows as needed. Another option is Oracle VirtualBox; this hasn't yet been officially released for Apple Silicon, but you can try out a Developer Preview of version 7.0.6.

Our preferred free choice is VMware Fusion Player 13.5, a full, mature virtualisation host that's

free for personal use: download it from **tinyurl.com/APC529vm**. The catch is that VMware doesn't natively support VHDX files, so if you've downloaded your Windows 11 installation media in that format, you'll need to convert it into VMware's own VMDK format. But that's not hard: open a Terminal window on your Mac and, assuming your VHDX file is in your Downloads folder, enter these two commands:

```
cd ~/Downloads
/Applications/VMware\
Fusion.app/Contents/Library/
vmware-vdiskmanager -r
Windows11_InsiderPreview_
Client_ARM64_en-us_22598.
VHDX -t 0 Windows11.VMDK
```

If your downloaded VHDX file has a different filename to ours then adjust the command appropriately. In a few moments you should have a new VMDK version of the installer file sitting in your Downloads folder.

Creating the VM

When you first open VMware Fusion Player, you'll see a welcome window headed "Select the Installation Method". If you want to download the commercial release of Windows 11, click "Get Windows from Microsoft" and hit Continue. On the next page that appears, leave "Windows Edition" set to "Professional" (this also supports the Home edition), select "English" as your language, and hit the "Download Windows" button. Told you it was easy.

If you're installing from the Insider Preview image, instead drag the VMDK file you just created into the installation window. VMware Fusion Player will automatically detect the platform and architecture of your installer (Windows 11 64-bit ARM), so hit Continue.

From here the setup procedure is largely the same whether you're using your own VMDK or an automatically downloaded image. The next page that appears asks you to confirm UEFI BIOS emulation – which you can do by hitting Continue – then invites you to set up a password for the virtual TPM inside your virtual Windows machine. You can click "Auto Generate Password" for this if you wish; it will be saved in your macOS Keychain if you ever need to refer back to it (for example, if you want to move your VM to another Mac or access it from a different user profile).

Hit Continue again to move onto the virtual disk setup page. If you're using the official installer downloaded by VMware, you can leave "Create a new virtual disk" selected and hit Continue. The default size is 64GB, but the image will only take up as much disk space as is needed to hold the files used by Windows – and if you need more space you can always expand it later.

If you want to install the Insider Preview, select "Use an existing disk", and navigate to your VMDK file in the requester that opens. Leave "Make a separate copy of the virtual disk" selected so that you still have a clean copy of the installer just in case.

Hit Continue one more time and you'll see a summary of your new VM configuration. You can optionally click "Customize Settings" to tweak the virtual hardware; the default settings will assign 4GB of RAM and two processor cores to your Windows VM, which is fine for lightweight desktop use, but you can increase these allocations if you want more headroom. Just remember that it's a balancing act, as these resources won't be available to macOS while the VM is running.

Once you hit Finish, VMware will prompt you to save your new VM, and you'll then see a black screen with a big "Play" symbol on it. You can click this – or the little icon at the upper left of the title bar – to "power on" your virtual machine.

Installing Windows

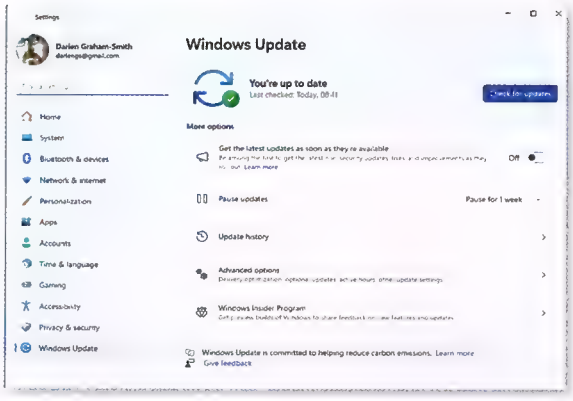
Turning on the VM brings up a simulated BIOS screen. If you're using the full release version of Windows 11 on ARM, you'll see a message saying "Press any key to boot from CD or DVD..." – and you should do this, as the installation files are on the virtual DVD drive.

You'll then shortly see the legacy Windows installer interface. This will prompt you with a few basic questions such as your region and keyboard preferences, which

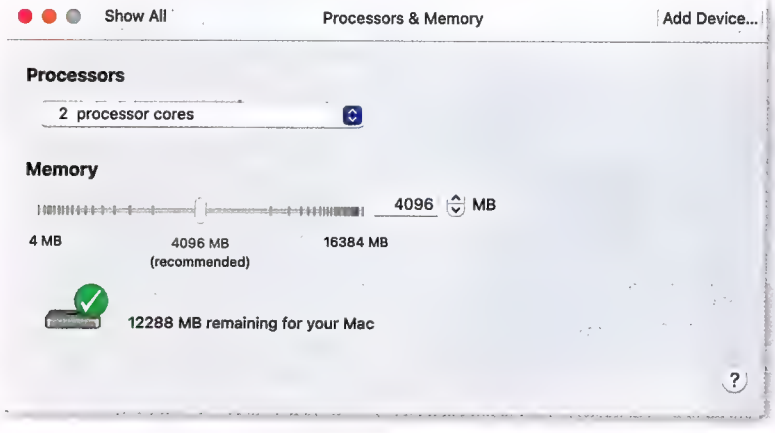
HOW LONG CAN YOU USE WINDOWS 11 INSIDER PREVIEW FOR?

When you first boot up Windows 11 on your Mac you may be rudely greeted by a banner telling you that your installation has expired. It seems Microsoft isn't updating its installation images all that regularly, so the OS you've just installed could be out of date on day one.

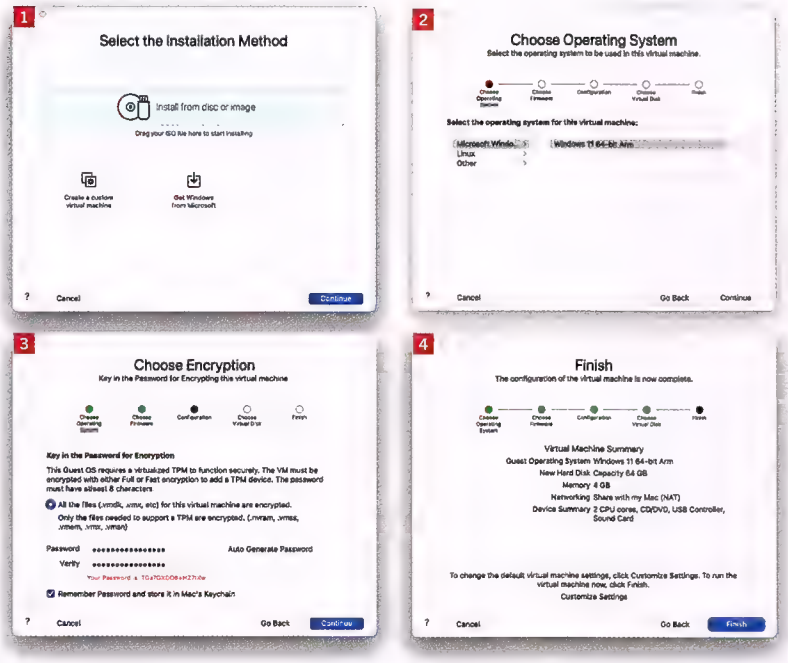
Don't panic – you can keep using Windows for as long as you like. You simply need to periodically download the latest build via Windows Update, just as you would on an Intel-based PC. Even if you've left the Windows Insider Preview programme, your Insider OS will still receive the latest patches and builds as they become available. Note, though, that there's currently no off-ramp: if you want to leave the testing track and switch to release code, you'll need to carry out a clean reinstallation of the OS.



ABOVE Keep your ARM edition of Windows updated in the usual way.



LEFT You may get a smoother ride if you can spare more than 4GB of RAM for Windows.



1 Open your converted image file, or download installation media from Microsoft. 2 VMware recognises your OS so you can click straight through. 3 You'll need to set a password for TPM emulation. 4 Tweak the virtual hardware settings to suit your needs, or go with the defaults.

edition of Windows you want to install and which hard disk you want to install it on. Once you've made your choices and started the installation process, the system will copy the files, reboot, spin for a few minutes, then launch the graphical setup wizard. If you're using the Insider Preview, the installation files are already in place, so your VM should boot directly into the setup wizard.

Once you see the opening screen of the wizard (which asks "Is this the right country or region?") you might naturally want to start working through it. Try this, though, and you'll quickly run into difficulties, as the installer needs network access, which in turn requires us to install a driver.

To do this, open the Virtual Machine menu and select "Install VMware Tools" (or "Update VMware Tools"); on the requester that appears, hit "Install" to mount the virtual disc containing the necessary drivers. Next, press Shift+F10 to bring up a Command Prompt – or, if that doesn't work, press Cmd+R to bring up the "Run..." requester and enter "cmd". Now enter:

d:setup.exe

This will launch the installer for VMware's tools and drivers. Click through it, accepting the default options, and reboot the virtual machine when prompted. When the installer comes back up, you'll now be able to complete the installation without any technical hurdles.

As part of the process the installer will ask you to name your device – something like WIN11-ARM should be nicely unambiguous – and whether you want to set it up for personal use, or for your work or school. Select the former, as this virtual machine isn't on a corporate network, and log in with your Microsoft account.

The installer will also offer to bring across your OneDrive files, preferences and apps from your most recently used Windows device; if you prefer a clean installation, click "View more options" and choose "Set up as a new device". You'll then be asked to permit all sorts of telemetry and personalisation services; it's a bit of a tiresome process, but you only have to go through it once.

Eventually, once you've been thoroughly questioned, the installer will spend a few more minutes building your user profile, and you'll finally be greeted by the familiar Windows desktop. What you do from here is up to you: you may well want to start by installing your commonly used programs.

You can also tweak your VMware Fusion Player settings to suit your needs. Dragging the edges of the window will dynamically resize your Windows desktop; display scaling can either be adjusted natively in Windows, or in VMware's System Settings | Display page. At present there's no way to set up native folder sharing between your Windows and Mac, but you can work around this by sharing folders via the network. The VM can be shut down, suspended or rebooted at any time via the Virtual Machine menu, and you can also instantly revert to a previous state via the Snapshots submenu.

For complete documentation on using VMware Fusion Player to run Windows 11 on Apple Silicon hardware, check out **tinyurl.com/APC529vmw** – and you may also want to check the unofficial guide at **tinyurl.com/APC529guide**. ■

WHAT NEXT FOR WINDOWS ON ARM?

The first ARM-based version of Windows was Windows RT, created in 2012 for the original Microsoft Surface tablet. It looked almost identical to Windows 8, but it only supported ARM-native code, and couldn't run existing Windows desktop apps. Unsurprisingly, it flopped.

Thankfully, Microsoft learnt from that experience, adding an application translation framework to the ARM editions of Windows 10 and 11. Now that ARM PCs can run regular Windows software, the platform is finally working its way into the mainstream: Microsoft's own Surface Pro 9 convertible is built on ARM silicon, as are a decent number of third-party Windows laptops.

Even so, ARM remains a second-class platform in the Windows world. The chips in those systems can't match the speeds of the latest processors from AMD and Intel, and running applications under translation doesn't help with performance or power efficiency.

That could soon change, though. Qualcomm just announced its new generation of "Snapdragon X" ARM processors, promising to bring Mac-rivalling performance and battery life to the Windows platform in 2024. There's more innovation and competition on the way, too, with both AMD and Nvidia reportedly working on rival ARM chips for release in 2025.

All of this means we can expect to see a lot more ARM-based PCs and laptops in the next few years – and as the market grows, developers will be increasingly incentivised to offer high-performance ARM-native versions of their applications. After more than a decade in the doldrums, it looks like Windows on ARM may finally get its chance to shine, and you can look forward to the benefits even if you're running it on your Mac.

1

Microsoft moved quickly to integrate an AI assistant on your desktop. **Ian Evenden** finds out how useful it can be.

Copilot is a new chatbot in Windows 11 that can do more than just search or crack jokes. It can launch apps, change settings, generate images, and talk to you in natural language. You can type or speak to it, and it will respond to your commands and queries. It is optional, and can be ignored like Cortana before it, but offers a new way to interact with your PC without using the mouse. You can find it on your Taskbar if you have the latest version of Windows 11 installed.

Copilot is a version of the Bing chatbot, incorporating DALL-E 3 and based on ChatGPT, that lives on your Windows desktop. You can ask it to change settings on your PC, search the web, generate images from text, and more. There's also voice input, so you can talk more naturally.

Copilot is still developing, and will get better and smarter in future updates. It is Microsoft's latest attempt to integrate an LLM into your PC, and make it more personal and convenient. According to Microsoft, Copilot is not just a chatbot; it is your assistant, but it doesn't always perform the way you might expect it to.

Update Windows

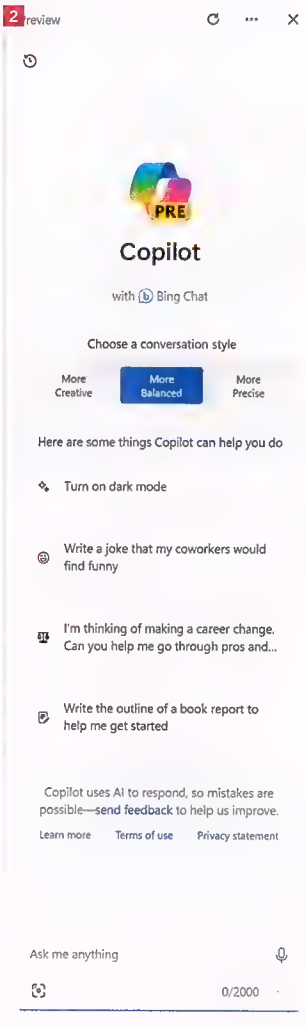
To get Copilot you're going to need the latest version of Windows 11, 23H2, though there has been talk of Microsoft bringing it to Windows 10 too. You know how to do this, but here it is anyway: open Settings, choose Windows Update, hit 'Check for updates', and let it do its thing. There has been some talk of Microsoft actually updating Windows 10 to support Copilot too, but we haven't seen any sign of it happening yet, so it may just be a rumour. Presumably, if it was to be integrated into the older OS, all it would do is tell you to upgrade.

> "You can ask it to change settings on your PC, search the web, generate images from text, and more. There's also voice input, so you can talk more naturally."

Find your Copilot

Copilot nestles in next to the Search box or button on your Taskbar, its pinky blue icon 1 making it look like something that conjures unicorns rather than a serious bit of AI coding. The version we're using has a 'pre' flash on it to tell us it's a preview version, though this should disappear in time. Click it, or use the Win + C shortcut, and you'll see a sidebar slide out from the right-hand side of the screen, pushing any tiled apps out of its way. This is the Copilot interface, and it looks rather unassuming. There's a text input field at the bottom, with a microphone icon so you can use your voice like Captain Kirk talking to his ship's

2


Preview
PRE
Copilot
with Bing Chat
Choose a conversation style
More Creative
More Balanced
More Precise
Here are some things Copilot can help you do
Turn on dark mode
Write a joke that my coworkers would find funny
I'm thinking of making a career change. Can you help me go through pros and...
Write the outline of a book report to help me get started
Copilot uses AI to respond, so mistakes are possible—send feedback to help us improve.
Learn more
Terms of use
Privacy statement
Ask me anything
0/2000

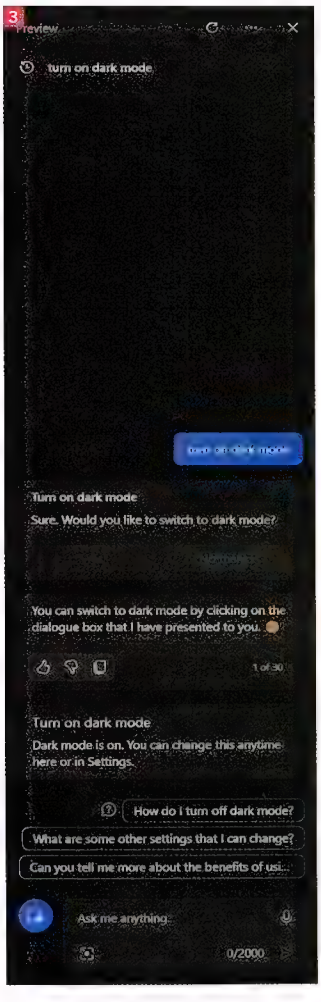
computer. Above this, there's a disclaimer to the effect that mistakes are possible in Copilot's replies. Going up, you'll find some examples of things you can ask for, such as pop art images, details of the latest features in CSS, and weird facts about the world. Truly, there's something for everyone. Then, nearer the top, you can choose conversation styles, making the AI responses more creative or precise. Above that, you get the Copilot and Bing Chat logos, with a refresh button and a few settings at the top.

Sign in

To generate images or make more than just a few requests, you'll need to sign in. You'll need to supply the email address and password for your Microsoft account – the one you use to log into Windows – as for some reason Windows doesn't pass this information along.

Make a simple request

The easiest way to get started with Copilot is to click one of the suggested questions [2]. "What is the concept of minimalism and how does it relate to productivity?" was one of the more eyebrow-raising suggested prompts we spotted, along with "Give me a list of new hobbies I could pursue with limited free time" – which raises the question of why we're not using that free time to build more PCs or play games on them – and recommendations for comedy shows on streaming services or book reports. Copilot has a broad range of interests, and hitting the refresh button at the top will generate new ones. We even got one asking about a career change, and frankly we were tempted.


3
Preview
turn on dark mode
Turn on dark mode
Sure. Would you like to switch to dark mode?
You can switch to dark mode by clicking on the dialogue box that I have presented to you.
1 of 30
Turn on dark mode
Dark mode is on. You can change this anytime here or in Settings.
How do I turn off dark mode?
What are some other settings that I can change?
Can you tell me more about the benefits of usi...
Ask me anything...
0/2000

If you don't feel that any of these suggestions resonate with you enough to click on them, then you can type your own in the text box at the bottom, or click the mic icon to use voice input. Whatever you choose, there will be a brief pause while Copilot communicates with whichever cloudy datacenter the LLM is running in, and you'll see the answer appear word by word just as if it were a human typing.

Wonder what on Earth it's doing

Copilot is new, so we're inclined to cut it some slack, but it can be baffling. Sometimes, simple requests seem utterly beyond it, while at others it responds quickly and accurately. Take a request to turn our PC's Wi-Fi on: the first response was about turning on Bluetooth, then it asked if we wanted to open the Settings app. Next came the offer of setting the PC's volume level to 100, then to turn Bluetooth off, and then to set the volume to 50. Eventually, we got a set of instructions that included clicking the network icon in the system tray, but the journey there was a bit chaotic. Type "turn on dark mode", and Copilot will do it [3], the change immediately reflected in your PC's windows and Taskbar once you've confirmed your decision.

YOUR GUIDE TO WHAT'S WHAT

1 REFRESH
Create a clean slate. This is useful if your Copilot window has become crowded.

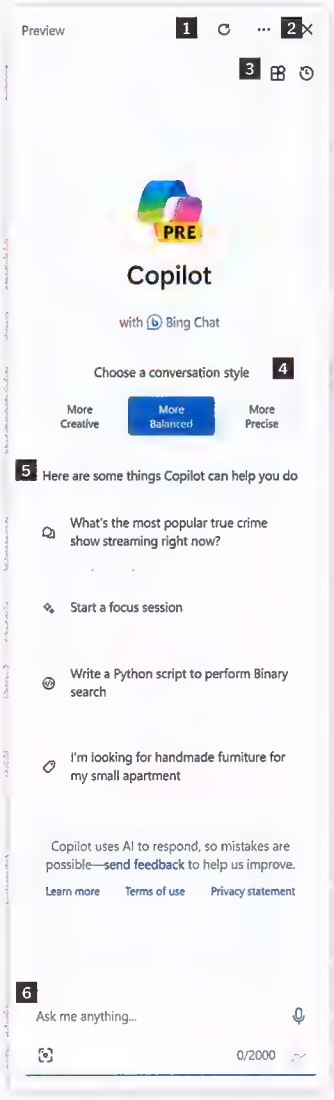
2 MENU
There's not much interesting behind here, just the option to share data with Bing.

3 PLUGINS
Add functionality from sites like Klarna or OpenTable for extra shopping fun.

4 CREATIVITY
Set whether you want Copilot to go wild, or (try to) stick to the facts.

5 SUGGESTIONS
Unsure what to do with your new chatbot? Try these suggested prompts.

6 INPUT BOX
Type here, or hit the mic icon for voice control. You can add images too.

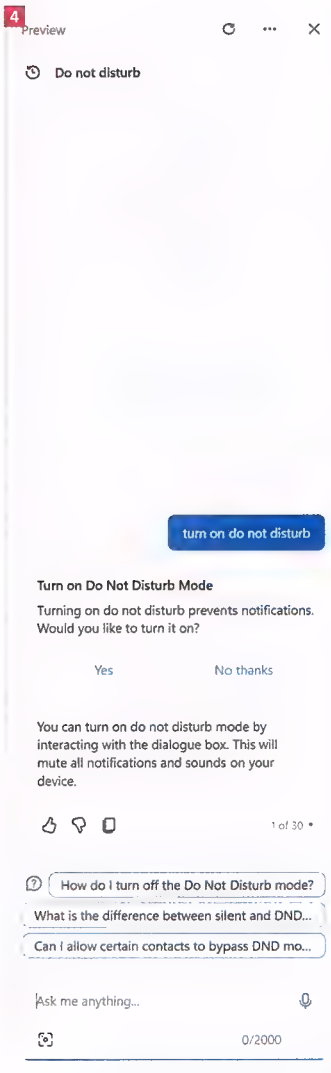


Prepare to wait, and click

Being able to turn on dark mode like this is fine, but a question arises: would it not be quicker to just do it yourself, once you've taken into account the time it takes to type the query, the cloud server to respond to the question, the confirmation box to appear and be clicked on, and for it to finally change? This doesn't seem like an efficient use of time or resources, at least for those who can use a mouse and keyboard fluently.

Another problem we found was that sometimes the confirmation box didn't work properly, and clicking it opened Edge, which took us to another Copilot window that contained helpful information about dark mode, which was less than ideal. The 'thinking' time Copilot exhibits, as well as the time it takes to input your prompts and requests, can slow you down if you're familiar with the locations of various settings in Windows, but could be useful for anyone who's either a newcomer to the OS, computers in general, or can't control their machine with a mouse.

When we asked Copilot to turn on the PC's Do Not Disturb function [4] to prevent notifications from breaking our concentration for a while, it provided instructions rather than taking control and changing the setting. However, its


Preview
Do not disturb
turn on do not disturb
Turn on Do Not Disturb Mode
Turning on do not disturb prevents notifications. Would you like to turn it on?
Yes
No thanks
You can turn on do not disturb mode by interacting with the dialogue box. This will mute all notifications and sounds on your device.
1 of 30
How do I turn off the Do Not Disturb mode?
What is the difference between silent and DND...
Can I allow certain contacts to bypass DND mo...
Ask me anything...
0/2000

instructions were a little wonky and likely to confuse a newcomer, pointing us to a mythical 'three line' button at the bottom right of the screen when the notification 'bell' icon was probably what it meant.

Handle text

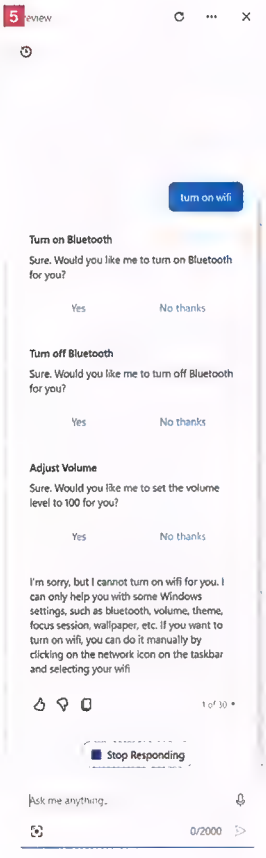
Copilot can do a number of tricks with text, many of which are also found in ChatGPT, as you'd expect. Input a paragraph or two, and it can rewrite it for you, although it failed to hit a set word count, even though it claimed it had.

We noticed that Copilot has a tolerance for typos, as when we failed to spell the word 'generate' anything close to correctly, it still managed to generate some images. We blame years of online gaming and trying to type too fast. What did confuse it, however, was when we wrote 'wifi' instead of 'Wi-Fi', as we apparently should have 5.

Create images

One of the most interesting things you can do with an AI assistant is use it to create images of things that don't exist. Earlier this year we looked at how to run the Stable Diffusion AI image generator on our own PC, and were plerplexed at some of the images of imaginary gaming PCs created with it. The images generated by Copilot, which uses the DALL-E 3 model from OpenAI, are much better – almost as if it understands what a PC is, and why it must be festooned with RGB lights.

They're simple to generate. We just typed "Create images of amazing gaming PCs" into the prompt box, and it did the rest. First, it returned images it had found on the web, with links to websites we could expect to find more of. Then it generated some images of its own, creating machines with recognisable components, fans, graphics cards, and RAM. We're not


turn on wifi
Turn on Bluetooth
Sure. Would you like me to turn on Bluetooth for you?
Yes
No thanks
Turn off Bluetooth
Sure. Would you like me to turn off Bluetooth for you?
Yes
No thanks
Adjust Volume
Sure. Would you like me to set the volume level to 100 for you?
Yes
No thanks
I'm sorry, but I cannot turn on wifi for you. I can only help you with some Windows settings, such as bluetooth, volume, theme, focus session, wallpaper, etc. If you want to turn on wifi, you can do it manually by clicking on the network icon on the taskbar and selecting your wifi
1 of 30
Stop Responding
Ask me anything...
0/2000

completely sure about the use of running games PCs as wall decorations, as shown in some of the images, but it's definitely something worth looking into. When we asked Copilot to give the specs of these RGB monstrosities, it came up with plausible suggestions, such as i9-11900K CPUs, AMD Radeon RX 6900 XT GPUs, and anything from 16 to 64GB of RAM. It went into detail about PSUs, cases, monitors (including display tech and resolution), and even headsets.

Be creative

Gaming PCs aside, the prompts you use should be broad and not too specific – unless you want to generate images of very famous people it will be able to find with a web search. Also, animal pictures tend to look better than human faces, which can sometimes appear distorted or unnatural. It has, however, got much better at accurate humans, with the number of teeth and fingers usually within normal parameters.

Here's an example: when we asked for "an image of someone building a pc like a mad scientist", we got four images, one of which captured the mood of the APC headquarters quite well, and the person depicted had natural-looking hands.

Copilot's image creator is a handy tool for getting images for various purposes – whether you need them for a newsletter, a website prototype, or just for fun. The images are square, in PNG format, and have a default resolution of 1024x1024px, which is slightly more than one megapixel.

Change its creativity level

An image of a giraffe playing PC games shows how creative Copilot can be when we adjust its setting to 'more creative'. The giraffe has a cartoonish look, a pizza slice, and three arms, which we did not specify, but it still looked impressive.

AI-generated images can be very realistic at first glance, but they often have flaws that reveal their artificial nature. That's why they are more of a fun curiosity than a serious threat right now, but that could change soon.

HOW DOES ALL THIS WORK?

Copilot is an LLM, (large language model) that runs in a data centre somewhere on a huge rack of GPUs. It's the same bot you'll find in Bing or Edge, and Microsoft has been busy recently rebranding its various bots under the Copilot name. The underlying tech is Microsoft Prometheus, an accelerated, distributed datacentre system, and the chatbot itself uses the GPT-4 large language model 'AI', and DALL-E 3 image generator.

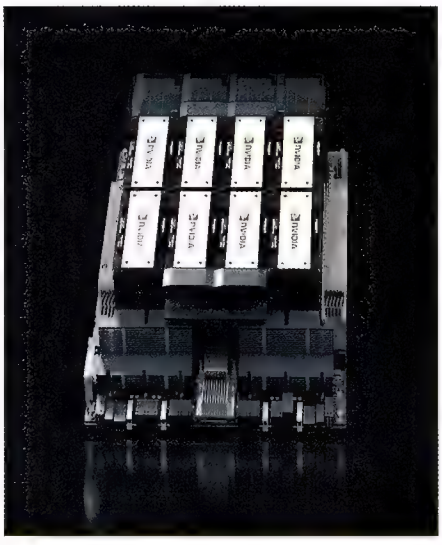
As a result, it doesn't run locally on your PC, and depends on an internet connection. This means there can be a lag between your text input and the answer, depending on the quality of your network and datacenter availability. Speed is also affected by Copilot's ability to search the web for more up to date answers than those provided by its training data. GPT 3.5 Turbo's knowledge base, for example, ends in September 2021. Microsoft is thought to be working on a way to increase the bot's responsiveness – though not its knowledge of breaking news – by making it possible to disable this web searching behavior. It's currently early days for Copilot, however, and many things are likely to change as updates roll in.

CUSTOM HARDWARE

Just as we were writing this tutorial, Microsoft announced what it calls a "systems approach to chips", and unveiled two custom-designed processors tailored for AI applications. These are the Microsoft Azure Maia AI Accelerator which will eventually underpin Copilot and is a 105 billion transistor design manufactured on TSMC's 5nm process, and the Microsoft Azure Cobalt CPU, an Arm-based processor tailored to run general purpose compute workloads on Microsoft Cloud.

Running cloud AI services can cost 10 times more than search engines, and the price of the GPU chips used has increased as demand has surged. Creating its own custom hardware allows Microsoft to sidestep this, and it's an approach taken by other players in the AI race, including Amazon with its Trainium and Inferentia chips, IBM's NorthPole, plus AMD's recently announced MI300 Accelerator. Even ChatGPT maker OpenAI is said to be looking into its own chips. Custom chips can be much more efficient than GPUs when running AI services like image classification or audio transcription, which helps to keep speeds up and costs down.

Nvidia isn't being left behind, however. Its new HGX H200 GPU (pictured) is bringing 4.8 TB/s of memory bandwidth to AI applications, and is expected to be used by Amazon Web Services, Google Cloud, Microsoft Azure, and Oracle Cloud Infrastructure, starting next year.



"An image of a giraffe playing PC games shows how creative Copilot can be when we adjust its setting to 'more creative'. The giraffe has a cartoonish look, a pizza slice, and three arms, which we did not specify, but it still looked impressive."

Get tips

The introduction of Copilot into Windows 11 coincides with the Tips app being put out to pasture. We're not sure how many people actually used it, as the 'don't show again' checkbox has always been one of the first things clicked on when setting up a new PC, but now it's on the deprecated list, we won't have to worry about that anymore. Copilot is now the home of tips on using Windows, and you can type simple queries into it to get a reply based on a web search. This is fine as long as the data from the web is accurate, but luckily Copilot shows its sources, so you can judge whether you trust the site in question.

Use it with Office... but not yet

Copilot can even help you with various tasks in Microsoft 365, or at least one day it will. The chatbot is not yet available for the home version of Office – you need to have the Enterprise edition with at least 300 users and a paid subscription. Copilot will likely be integrated into all versions of Office in the future.

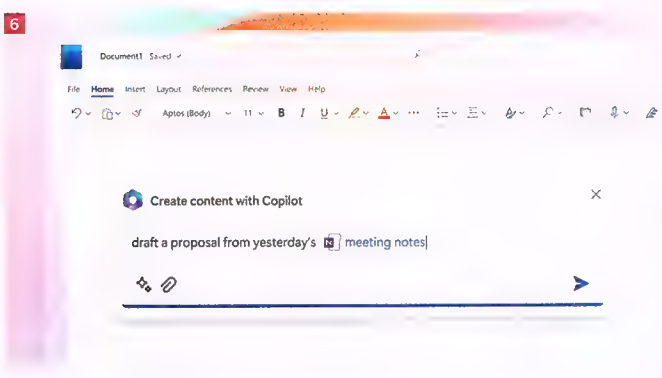
If you have access to the 365 version of Copilot, you can select it from the Ribbon menu and open it as a sidebar in the app 6. Then you can type commands or questions to ask Copilot to do something for you. For example, you can ask Copilot to summarize a long document by typing 'summarise this document' without needing to paste anything into the Copilot input box. Copilot will generate a short summary, but it will need to be checked for accuracy. The same can be done for a Teams call or chain of emails.

Copilot can also automate many common data analysis tasks in Excel, such as "Break down sales by type and create a table". Copilot will one day be able to save office workers time and effort if its results are reliable, but it's not there yet.

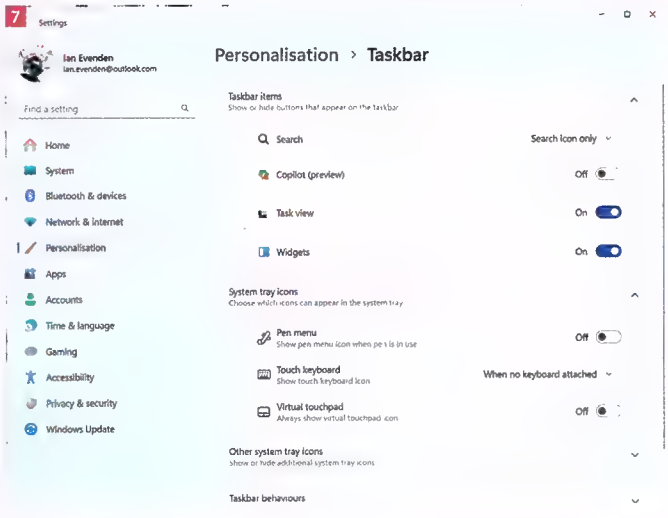
Turn off Copilot

If you decide that AI isn't for you, and would rather its icon didn't contaminate your Taskbar any further, then you can remove it in Settings. While it only removes the icon, Copilot itself remains installed as it's now part of Windows. Open the Settings app, find the Taskbar settings in Personalisation, and you'll be able to slide a switch over to the 'off' position to never see Copilot again 7. ■

6


Document1 Saved
File Home Insert Layout References Review View Help
Aptos (Body)
Create content with Copilot
draft a proposal from yesterday's meeting notes

7



PC BUILDER

From the front lines of the Australian PC market

System news

Mark Williams looks at what 2024 and beyond will hold for chip manufacturing.

As 2024 begins we have an exciting year of product releases to look forward to. We'll see AMD CPUs being manufactured on TSMC's N5 node, Nvidia using TSMC's 4N (a derivative of N5), and both AMD and Intel using TSMC's N5 and N6 nodes for their GPU lineups. TSMC is obviously the biggest and most important manufacturer in the computer industry, and seeing what it has been developing and is going to make available to their customers will directly affect the products that we'll buy.

TSMC recently held its Open Innovation Platform (OIP) Forum where it laid out some of the new process nodes it'll be bringing to market and rough expected performance targets it is seeing from each.

The first thing to note is that TSMC's 3nm class of processes are all FinFET transistor-based and started production in 2022 for Apple and its A17 Pro phone SoC made with TSMC's N3 node. With Apple paving the way for TSMC to ramp N3 production with buckets of money, TSMC is now able to fine tune the N3 node for other use cases. With N3 defect rates mirroring that of N5 (that is, very good) it's expected yields for the N3 family will also be excellent.

The second iteration of N3 comes with N3E, similarly dense version of N3 but with a 5% frequency bump. N3E when looking at it from our current N5-based processors (using an ARM Cortex A715 as a reference) offers a huge 18% frequency bump, over 30% density improvements and over 32% in power efficiency gains. Very nice indeed!

N3E production started in 2023 but it's likely the next node, N3P that will have us the most excited. Where N3E gave a 5% increase to frequency at the same density over N3, N3P will give 10% extra to frequency and 4% to density. This node will likely be where Nvidia, AMD and Intel gravitate towards for next gen parts and will begin volume manufacturing in the second half of 2024.

In 2025 comes the N3X node, optimised for higher voltages to eek out an extra 5% frequency over N3P.

From the second half of 2025 onwards will be TSMC's next big leap with a Gate-All-Around transistor touting N2 node, which it expects will see a 5-15% frequency bump over N3E, with greater than 15% density and up to 30% power efficiency gains.

Beyond N2 is N2 + BSPDN (Backside Power Delivery Network) and of course N2P and N2X which should give similar uplifts that N3P and N3X will to N3. However, N2 + BSPDN will be a game changer and presented as an option to customers, and will move all power delivery for the transistors to the back of the chip instead of mixed in with all the signal connectors on the front of current designs. This will allow for 10% in density and frequency improvements that have simpler design rules over the regular N2 node thanks to less crosstalk. We're looking out at 2026 for this though.

It's great to see that silicon chip manufacturing isn't standing still and hasn't hit a brick wall yet, despite drawing ever closer to the physical limits. At least for now, we've got good amounts of frequency and power efficiency improvements to look forward to in future CPU and GPU products!

Mark Williams is an IT professional with a strong interest in voiding warranties.

Market Watch

A sampling of PC systems available this month

AUSTIN COMPUTERS READY TO GO (OP-S03382)

$1,899

tinyurl.com/APC529ac

When sticking to a tight budget, this is the sort of system that ticks all the right boxes. It's not so cheap as to cut back on fundamentals, but also not costing any more than is required to get the job done if 1080p gaming is your jam.

The Intel 400F CPUs are always great value and paired with Nvidia's latest 60 series GPU this system will get you humming along in no time with any game, just bear in mind that 8GB frame buffer will keep you limited to 1080p resolutions for the most part.

A good-sized SSD and typical RAM capacity are both solid ticks and the PSU is adequate to power the gear included. A solid system for the price.

CPU Intel Core i5 13400F; **COOLER** OEM; **MOTHERBOARD** Asus Prime B660M-A WIFI D4; **GRAPHICS** MSI GeForce RTX 4060 Ventus 2X Black 8GB OC; **MEMORY** 16GB Corsair Vengeance RGB RS DDR4 3600MHz C18; **STORAGE** 1TB PNY CS1031 NVMe SSD; **POWER SUPPLY** FSP HP2-600M Hydro M PRO 600W; **CASE** FSP CST360B.

CPL ONLINE CODE15

$1,849

tinyurl.com/APC529cpl

At first glance this system seems behind the times. A generation older CPU and GPU when compared to the similarly priced Austin Computers rig, it is hard to look past, especially at the price. Sure, the newer parts didn't improve much, maybe an extra ten percent, but this system makes up for it in other ways.

The motherboard has the newer B760 chipset, for faster PCI-E 4.0 links to the chipset. This also has double the RAM and a beefier PSU that'll support more substantial system upgrades.

Mass storage is technically more but split with a smaller SSD. Not as great out of the box but possibly a better longer-term choice if you'd like to do some upgrades later.

CPU Intel Core i5 12400F; **COOLER** OEM; Motherboard Asrock B760M PRO RS/D4 WIFI; **GRAPHICS** Gigabyte GeForce RTX 3060 Aorus Elite 12GB; **MEMORY** 32GB Team T-Force Zeus DDR4 3200MHz; **STORAGE** 500GB Samsung 980 NVMe SSD, 2TB Seagate Barracuda HDD; **POWER SUPPLY** Thermaltake ToughPower 750W; **CASE** Nzxt H710 White.

SCORPTEC VOID RTX 4080

$4,199

tinyurl.com/APC529sc

For the asked chunk of cash this system offers some of the best gaming experiences available. Sure, it hasn't the top tier RTX 4090, but it's also not asking for $7,000 from your wallet. The RTX 4080 is powerful enough for 4K gaming with all the RTX bells and whistles enabled, even if it's not so great value for the money.

The best gaming CPU is inside and cooled by a wholly unnecessary AIO, but at least keeps the aesthetics nice.

A roomy 2TB SSD and large capacity PSU round out a very capable and not overly pricey system considering the amount of gaming performance on tap.

CPU AMD Ryzen 7 7800X3D; **COOLER** Corsair H100 RGB CPU Cooler; **MOTHERBOARD** MSI MAG B650 Tomahawk WiFi; **GRAPHICS** MSI Ventus 3X GeForce RTX 4080 OC 16GB; **MEMORY** 32GB Corsair Vengeance RGB 6000MHz DDR5; **STORAGE** 2TB Kingston KC3000 M.2 SSD; **POWER SUPPLY** Corsair RM850e 850W; **CASE** Corsair iCue 4000D RGB Airflow.

BPC TECH KRAKEN POWER DOMINANCE

$4,599

tinyurl.com/APC529bpc

Costing $400 more than the Scorptec system, this lives up to its name with a lot more computational power under the hood. The twelve core 7900X CPU isn't the gaming champ the 7800X3D is, but it has more resources to throw at demanding CPU loads. If you work and game this is a nice balanced choice.

The RX 7900 XTX also does better than the RTX 4080 if you keep raytracing out of the equation and has 50% more VRAM to boot.

The 1TB SSD is a let down at this price, but the better X670E motherboard, 1000W PSU and 360mm AIO at least cover the loss in value there and offers a system that's capable across many workloads.

CPU AMD Ryzen 9 7900X; **COOLER** Asus ROG Ryuo III 360 ARGB AIO; **MOTHERBOARD** Asus TUF Gaming X670E-Plus WIFI; **GRAPHICS** Asus TUF Gaming Radeon RX 7900 XTX OC Edition 24GB GDDR6; **MEMORY** Corsair Vengeance RGB 32GB DDR5 6000MHz C40; **STORAGE** 1TB Lexar NM790 NVMe SSD; **POWER SUPPLY** FSP Hydro PTM PRO 1000W; **CASE** Lian Li PC-011 Dynamic XL RGB.

Blueprints

Value- and performance-driven hypothetical builds

Budget. A perfect balance between price and performance.

We're in that weird in-between space right now where parts are coming in and out of circulation. Intel's 14th gen has just landed, and new AMD chips and Nvidia GPUs are on the horizon, so the market is struggling to decide what goes on offer, and what the pricing of products should be. That puts us in an awkward position when it comes to selecting parts for our blueprints. Nevertheless, we've purged some of the more chaotic parts in favour of a few choice component upgrades instead.

Our AMD system had the biggest shake-up, with six new components, alongside a platform change. Yes, we blew away the Ryzen 5 5600, and replaced it with its successor chip, the 7600. This means a new socket and an AM5 motherboard, alongside some sweet DDR5. Fortunately, they're all good picks, and despite being on the bottom end of the budget spectrum, these will do you well in professional and gaming-oriented tasks. According to our testing, that RX 7600 is a pretty solid unit, more than capable of maintaining 60 fps and above on Ultra at 1080p.

Intel also got hit by the build hammer – again this was mostly down to the market fluctuating. The changes were less dramatic, but we did grab some speedier memory, alongside a slight downgrade to the RTX 4060. That said, the 4060 is a solid unit, and clocks average frames in most games close to 100+.

To balance the books, we've changed our storage solutions. It's about time we called EOL on those pesky HDDs. Don't get us wrong, if you need a full NAS solution, they're still valuable, but with the advent of cloud storage, and cheap and affordable M.2s and SSDs, it's hard to justify a big bulky 3.5-inch spinning disk. That said, both builds benefit from 2TB of crisp, clean PCIe 4.0 storage. Sadly, only the Intel board will run both drives at full speed, so the AMD board is definitely a 'buy now, upgrade motherboard later' (although you still get PCIe 3.0 speeds).

AMD BUILD - Approximate Price $1,586

Case	Corsair 4000D Airflow	$149
PSU	600W EVGA 600 BR 80+ Gold	$79
Mobo	**Asus TUF Gaming A620-Plus WiFi ATX AM5**	**$269**
CPU	**AMD Ryzen 5 7600**	**$339**
GPU	**XFX Speedster Swift 210 Core RX 7600 8GB**	**$454**
RAM	**16GB (2x8GB) Teamgroup Elite Plus DDR5 @ 4800**	**$82**
SSD	**1TB MSI Spatium M450 PCIe 4.0 M.2**	**$75**
SSD	**1TB Teamgroup T-Force Cardea Z44L PCIe 4.0 M.2**	**$79**
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60

INTEL BUILD - Approximate Price $1,510

Case	Corsair 4000D Airflow	$149
PSU	600W EVGA 600 BR 80+ Gold	$79
Mobo	**Asus Prime B760-Plus ATX**	**$265**
CPU	Intel Core i5-12400F	$205
GPU	**Gigabyte Windforce OC RTX 4060 8GB**	**$499**
RAM	**16GB (2x8GB) Corsair Vengeance DDR5 @ 5200**	**$99**
SSD	**1TB MSI Spatium M450 PCIe 4.0 M.2**	**$75**
SSD	**1TB Teamgroup T-Force Cardea Z44L PCIe 4.0 M.2**	**$79**
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60

AMD BUILD - Approximate Price $2,863

Case	Nzxt H7 Flow	$189
PSU	NEW 750W Corsair RM750e - 80+ Gold	$169
Mobo	NEW MSI PRO X670-P WiFi ATX - AM5	$465
CPU	NEW AMD Ryzen 7 7700X	$549
Cooler	NEW Be Quiet! Pure Loop 2 - 240mm AIO	$149
GPU	NEW PowerColor Fighter OC Radeon RX 7700 XT 12GB	$779
RAM	NEW 32GB (2x16GB) Corsair Vengeance RGB DDR5 @ 6000	$209
SSD	1TB Lexar NM790 PCIe 4.0 M.2 SSD	$95
SSD	NEW 2TB Gigabyte Aorus Gen4 5000E PCIe 3.0 M.2 SSD	$199
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60

INTEL BUILD - Approximate Price $3,153

Case	Nzxt H7 Flow	$189
PSU	NEW 750W Corsair RM750e - 80+ Gold	$169
Mobo	NEW MSI Z790 Gaming Pro WiFi ATX	$399
CPU	NEW Intel Core i5-14600KF	$889
Cooler	NEW EK-Nucleus AIO CR360 Dark	$245
GPU	NEW MSI Ventus 3X OC RTX 4060 Ti 8GB	$699
RAM	NEW 32GB (2x16GB) Corsair Vengeance RGB DDR5 @ 6000	$209
SSD	1TB Lexar NM790 PCIe 4.0 M.2 SSD	$95
SSD	NEW 2TB Gigabyte Aorus Gen4 5000E PCIe 3.0 M.2 SSD	$199
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60

Mid-range. A game-ready machine that can also handle demanding work.

Cometh the hour, cometh the Mid-range, and here we are with another barrage of new components. Like our budget-build, it's been a challenge finding the right components without stretching the price too far. That said, we've made some subtle changes that should impact performance pretty solidly.

AMD is up first on the chopping block. We ditched the 7600X in favour of the 7700X for the additional cores, then pushed for a better motherboard in the form of MSI's PRO X670-P, alongside a more modern GPU: the 7700XT. The latter's a solid unit, averaging around 60fps at 1440p. The VRAM is a minor concern for long-term performance, but we're confident it'll hold for the next few years. This is one area we would recommend pumping in a bit more cash, however, as the rest of the system is solid, and we're arbitrarily setting ourselves a $3,000(ish) target for both builds.

"Like our budget-build, it's been a challenge finding the right components without stretching the price too far. That said, we've made some subtle changes that should impact performance pretty solidly."

As for Intel, we've chucked out the 13600K in favour of our CPU pick this issue, the 14600K. It's proven its worth, and given the 13600K is now almost out of stock everywhere, it's a matter of time until it's extinct good and proper. We've also saved enough cash by swapping to the slightly lower-spec 4060 Ti (the 4070 deals have all vapourised) to plump for a beefier cooling solution, upgrading to a 360mm AIO. But didn't we just say that 12GB of VRAM was cause for concern? Yes. Doesn't that GPU have 8GB? Yes. If you can, get the 16GB variant instead. You'll still find yourself comfortable at 1440p, but more VRAM is always better.

As for shared componentry, we've pumped both builds up with a new PSU, with an 80+ Gold rating instead of the Bronze EVGA unit, and gone for a beefier secondary SSD, ditching the HDD for a 2TB PCIe 4.0 drive. You'll also note that we've opted for the same set of DDR5 memory. This pumps 32GB of 6000 MT/s memory out the gate, and should be more than enough for any video-rendering tasks or more creative avenues of fun.

High-end. A game-ready machine that can also handle demanding work.

Things are heating up in Turbo land with the arrival of Intel's 14900K, and AMD has responded, and responded hard. The 7950X3D is down to an incredible $829 to combat Intel's Core i9 pricing. Whether that's enough to entirely stem the tide is unknown at this point, but it just goes to show how much AMD considers the 14th gen a threat, despite its lackluster arrival.

In other news, it's staggering to us just how affordable 4TBs of PCIe 4.0 SSD are these days. $469 for a heck of a solid M.2 from Teamgroup – that's not too shabby at all. Okay, it's not 6TB of spinning platter (you do lose out on that 2TB extra, and a bit of cash), but the read and write speeds are more than worth it.

We've made some big changes across the board once more, opting for a 1200W PSU across both builds and tweaking the motherboard selections to provide a better serving of I/O for those premium professionals out there. Additionally, we plumped for an LCD cooler (which was weirdly cheaper than the non-LCD variant), and also changed the primary SSD over to a PCIe 5.0 solution instead (just remember to stick it under your motherboard's heatsinks please, as these things run hot).

As for AMD, changes have been fairly minimal. We've gone for a slightly speedier DDR5 kit to better benefit from Ryzen's Infinity Fabric memory scaling capabilities. We've also grabbed a slightly higher spec 7900XTX to ensure that 4K gaming stays resolutely in the 80-90 fps range.

For Intel, we've gone a bit of a different route, dropping the 14900K for the KF variant instead, and going for a 16GB PNY RTX 4080 (again to hit that 4K 80fps mark). But the biggest change by far is the memory kit. G.Skill has a fantastic trident Z5 kit available running @ 6800 CL34 (ideal for that memory controller in the 14th gen), it's even cheaper than the 6000 CL30 in the AMD build. What's the catch? Well, it's a 48GB kit. Yes, we're doing that now. Earlier this year, a number of manufacturers jumped on the 24GB DIMM stick bandwagon. It provides a fantastic sweet-spot in the DDR5 ranges right now, particularly with the larger capacities, and can save you money, too.

AMD BUILD - Approximate Price $5,721

Case	Phanteks Enthoo Pro 2 Tempered Glass	$299
PSU	NEW **Be quiet! Straight Power 12 1200W - 80+ Platinum**	**$409**
Mobo	NEW **Asus Prime X670E-Pro ATX - AM5**	**$589**
CPU	AMD Ryzen 9 7950X3D	$829
Cooler	NEW **Nzxt Kraken Elite 360 RGB - 360mm AIO**	**$479**
GPU	NEW **Sapphire Nitro+ RX 7900 XTX 24GB**	**$1,799**
RAM	NEW **64GB (2x32GB) Corsair Vengeance RGB DDR5 @ 6000 CL30**	**$339**
SSD	NEW **2TB Corsair MP700 PCIe 5.0 M.2**	**$449**
SSD	NEW **4TB Teamgroup T-Force Cardea Z440 PCIe 4.0 M.2**	**$469**
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60

INTEL BUILD - Approximate Price $5,781

Case	Phanteks Enthoo Pro 2 Tempered Glass	$299
PSU	NEW **Be quiet! Straight Power 12 1200W - 80+ Platinum**	**$409**
Mobo	NEW **Gigabyte Z790 Aorus Elite AX-W ATX**	**$499**
CPU	NEW **Intel Core i9-14900KF**	**$889**
Cooler	NEW **Nzxt Kraken Elite 360 RGB - 360mm AIO**	**$479**
GPU	NEW **PNY Verto RTX 4080 16GB**	**$1,839**
RAM	NEW **48GB (2x 24GB) G.Skill Trident Z5 RGB DDR5 @ 6800 CL34**	**$389**
SSD	NEW **2TB Corsair MP700 PCIe 5.0 M.2**	**$449**
SSD	NEW **4TB Teamgroup T-Force Cardea Z440 PCIe 4.0 M.2**	**$469**
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60

PC GAMER

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The problem solvers

The *APC* team field problems across the spectrum of devices and software. Learn a new trick or fix you can use.

Data recovery question

A friend recently switched from Mac to PC, and made the mistake of somehow wiping his drive because it wasn't visible in Windows (as it had been formatted in Apple's own APFS format). He compounded the error by creating a new Apple APFS volume over the top of the original partition in a misguided effort to undo his original mistake. I've run several drive-recovery tools, but while they're able to see the drive's previous content, none of the files appear to be recoverable, even though no new files have been written to the drive. Why is this so, and is all his data lost?
Eric L Dumont

APC Responds: This comes down to the fact that most of the files in question have become fragmented over time. When fragmented files are deleted, even though only the first few bytes of the file are overwritten to leave the file contents largely intact until the space is overwritten with other data, there's no information in the file itself that records where the fragments reside.

That critical information is typically stored in the Master File Table (MFT), an area on the disk reserved for ensuring the OS can find not just where a file starts, but where it resides on the disk. This makes recovering deleted files from an existing partition a simple task, but when the partition is wiped, the MFT can be lost – this is certainly the case with older FAT/FAT32-formatted drives. NTFS backs up the MFT and stores these copies across the drive, making it easier to recover this information and improve the chances of recovering fragmented files.

However, the newest Apple file system (APFS) works differently to both NTFS and its own predecessor (HFS+). It seems that once the file system has been wiped and a new partition – even an 'empty' one – created on top of it, key information regarding the previous file system is lost. The drive's contents can be viewed, but the only way you're going to recover any data is through a raw file recovery.

The best tool for the job is DMDE (**https://dmde.com/**), which can read and recover data from Mac-formatted drives even from a Windows machine. Once installed, launch the program. Leave Physical Devices selected, select the external drive, and click OK. Next, click Full Scan, make sure Raw is checked, and click Scan. Wait for it to complete, then expand the Raw section to reveal a hierarchy of file types. Right-click each one, and choose 'Open Raw results only'.

A list of document types like Archives, Documents, and Graphics will be shown, inside each of which are related file types. Select one to view its contents, then double-click a file to view a preview. You can retrieve 4,000 files at a time from a single folder/file type in the free edition by right-clicking the parent folder and choosing Recover / Create File List, and following the prompts. Make sure you recover to a separate drive, and then the process of going through the list to identify and rename individual files can begin.

The GeForce 1650 is our GPU choice for power-conscious users.

Low-powered GPUs

We don't see a lot written about graphics cards that don't cost a mint or burn electricity like a space heater. I have an Nvidia GeForce 1050 Ti in each of my two desktops, but I rue the day when they fail (again). Is there a current-generation graphics card equivalent to a 1050 Ti that will run a 4K monitor and run on under 100 watts?
John Weiss

APC Responds: A superficial look at the current generation of graphics cards would suggest that there are no current-generation cards that meet your specifications, although the GeForce RTX 4060 comes close with a total graphics power rating of 115W. However, Nvidia has started providing a range of power ratings for its 40 series models – and looking at these figures, the RTX 4060 is rated at 7 (idle), 11 (video playback), and 110 (gaming) watts respectively. This suggests that in day-to-day use, you can expect the card to draw significantly less than 100W. Expect to pay $400 upwards for an entry-level RTX 4060.

If that's too high for your budget, then there's still plenty of choice – so long as you're willing to work with previous-generation tech. 4K support is well-established – your existing GeForce 1050 Ti cards already support it. If your budget is tight, then the GeForce 1650, introduced in 2019 and still widely available, should tick your boxes. It has 8K support and draws a maximum of 75 watts, even under load. You can pick up a MSI Ventus GeForce GTX 1650 for around $200.

If you want something newer, AMD's Radeon 6400 dates from 2022, and has a power draw of 53 watts, so it gets its power from the PCI-E port. With prices also starting from around $200, it seems the obvious choice – however we prefer the older GeForce 1650, particularly if your

workflows benefit from hardware video encoding.

Identify network device

A few days ago, my Synology router started throwing up a flurry of notifications saying it had blocked access to a certain IP. The warnings refer to a hardware MAC ID, but no IP address. How can I identify where the request is coming from, so I can better evaluate it?
Mary Metcalf

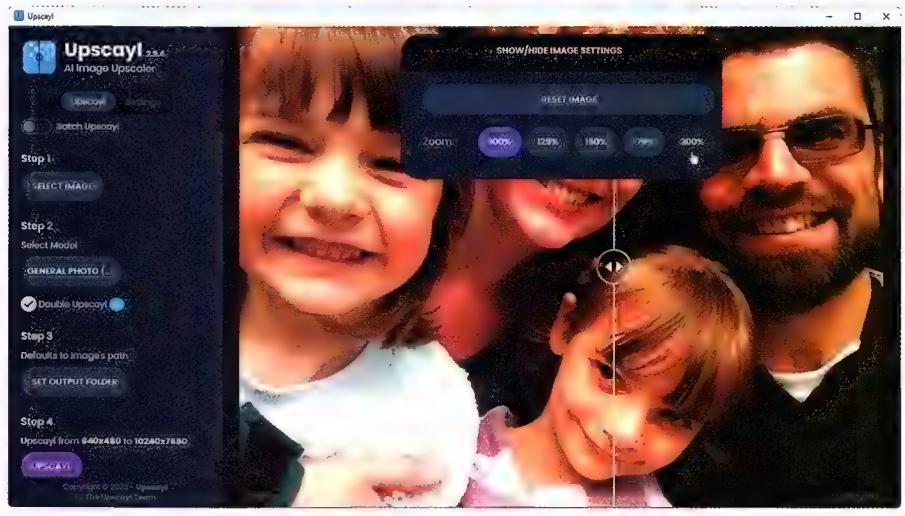
***APC* Responds:** There are typically three things you can identify about network devices using software (or your Synology router): the IP address they've been assigned on your network, their uniquely identifiable eight-digit hexadecimal MAC address, and (if you're lucky) the device name or manufacturer. You can get this information from your Synology router by logging in to its web interface, navigating to Network Center, and switching to the Device List tab under Status.

Mary followed our advice, and was able to link the device's MAC address to its IP address on the network, manufacturer, and the fact it was connected via Ethernet cable. The manufacturer was revealed to be Microchip Technology Inc, which manufactures a range of semiconductor parts. As it's not known for producing specific products, this didn't help her much; however, it was likely to be linked to some network-connected piece of smart technology, so Mary was able to examine each piece of kit in her house to see if the MAC address was listed on its label.

This led her to her Sure Microchip Cat Flap Connect, or more precisely its hub, which transmitted the data recorded by the flap of her pet's incomings and outgoings to an app via the internet. With Synology blocking communication with a specific remote IP address, Mary had two options: whitelist that IP address in her router, or exclude the Connect hub so its traffic is no longer monitored by the router. This can be done via Safe Access > Security > Exception List tab. Click Add to enter either the remote IP address or that of your network device, provide a description, and click OK.

Rather than whitelist the unsafe IP address, which would put all Mary's devices at risk from traffic from that source, we advised her to whitelist the cat flap, and look at creating a dedicated VLAN, which would isolate the cat flap from all other network devices. If the cat flap is connected to the router, follow the guide at **https://kb.synology.com/en-global/SRM/tutorial/Synology_VLAN_Deployment_QSG** to configure it; if the cat flap is connected through a smart switch you can configure the VLAN from there instead.

> "We have been experimenting with an open- source, free desktop tool called Upscayl, which allows you to upscale photos to four times their normal size."



The right AI model can produce miracles.

Installer error

I tried to install the latest version of OBS Studio, but it keeps failing with an error saying 'CefSharp.BrowserSubprocess' won't allow it. What is this, and how do I get past it?
Thomas Stamper

***APC* Responds:** This file is part of the Chromium Embedded Framework (CEF), which basically allows apps to incorporate web-based elements in their own user interface. The error occurs because another program or process is using it.

We were eventually able to track the process to DeepL (**www.deepl.com**), an online and app translator. Closing the app via its system tray icon removed the block, allowing OBS Studio to complete its installation. From that point, both programs ran side-by-side.

If you find yourself in a similar situation, use Microsoft's Sysinternals Process Explorer (**https://learn.microsoft.com/en-us/sysinternals/downloads/process-explorer**). This lists all processes in a hierarchical structure, making it easy to trace one process to its parent using Find > Find Handle or DLL. Type 'cefsharp', click Search, then double-click the Process entry to view the process tree, with the culprit at the top.

Disappointing AI upscaling

I've been trying several free AI upscaling services, but they all seem determined to produce results that make it look like the subjects have over-sculpted their faces for social media. Is there anything that avoids these results?
Joseph A Hughes

***APC* Responds:** We have been experimenting with an open-source, free desktop tool called Upscayl (**www.upscayl.org/#desktop**), which allows you to upscale photos to four times their normal size. However, while the default model – General Photo (Real-Esrgan) – delivers problematic results on many photos, another option called General Photo (Remacri) seems to produce more natural results. You can switch models using the dropdown menu on the main screen – Upscayl does, however, require a Vulkan-compatible GPU, so works best with discrete AMD and Nvidia cards, although there is a workaround (**https://github.com/orgs/upscayl/discussions/580**) that should work for other graphics chips, including integrated Intel graphics, too. ■

Store more photos

Nik Rawlinson on how to beat OneDrive's photo storage restrictions.

YOU'LL NEED
OneDrive account, Mega.io account
OneDrive online (free), or a Microsoft 365 subscription (paid). Mega.io account (free)

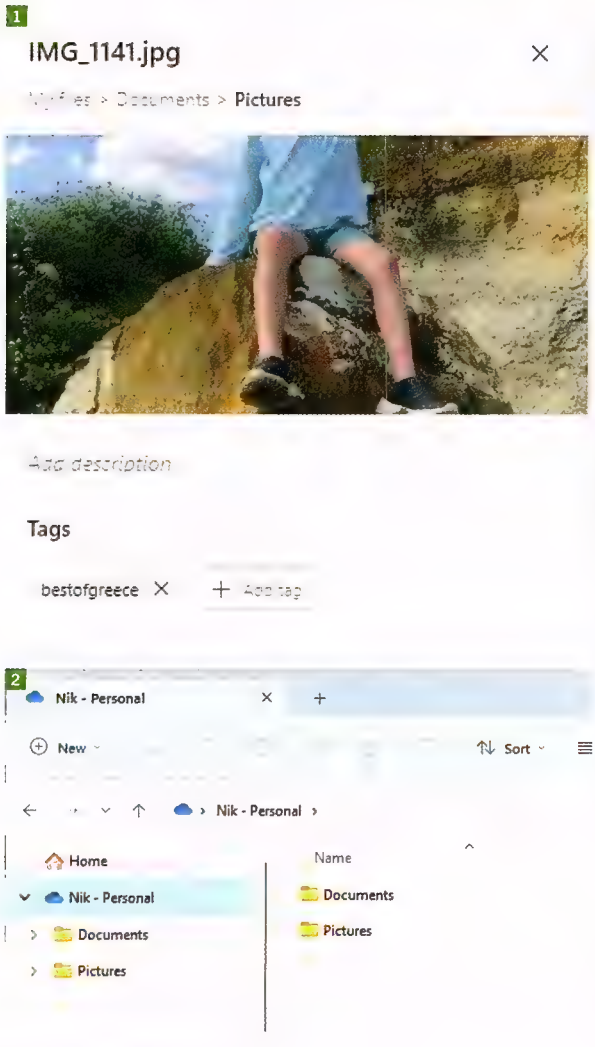
Online storage providers want you to synchronise as much as you can – the more you upload, the more they can charge you for storage. Because you're likely to upload your files and not touch them for years, the charges can roll over month to month, perhaps forever. No wonder they make it so easy to sync automatically.

Take Microsoft's OneDrive. Its software is built into Windows, and OneDrive is the default location for saving Microsoft Office files. The program also lets you sync your Desktop, Documents, and Pictures folders, save photos and videos from other devices, and automatically upload screenshots. This is useful, but syncing a lot of files can push you towards the limits of your account, so you may need to upgrade to a more expensive plan.

But that's not the only way you might use more space than you expect. Microsoft recently told some OneDrive users that from mid-October 2023 adding a photo to an album would mean it counts twice against their allocated storage. This won't be such an issue for Microsoft 365 subscribers, who get 1TB of storage, but it's something to watch out for on the free 5GB tier.

When you add a photo to an album, you don't remove it from its location; you just make it visible within a certain context. Think of an album like a perforated grille, which blocks out all but the images that you've associated with it. Opening an album is like taking a bird's-eye view at your library through that grille, so that only a subset of the pictures remain visible.

It seems unfair, then, that an image in an album should count twice against your storage quota. We explain how to avoid falling foul of OneDrive's storage limits.



Add your own photo tags

When you upload an image, OneDrive applies tags based on what it thinks it depicts. You can use these to search your library later.

You can also add tags of your own, and more or less work around Microsoft's double counting. Let's say you've visited Greece every year since 2015. If you took every photo on your smartphone, they will already be tagged with both Greece and the date, plus whatever else OneDrive thinks each image shows.

If you wanted to create a collection of only your best shots from the last eight years of visits, then rather than creating an album called 'Best of Greece' and having their size counted twice, you could instead add the tag bestofgreece to your favourite shots from each of your visits.

To do this, log into your account at **https://photos.onedrive.com**, hover over the photo you want to tag, and click the 'i' that appears in the bottom-right corner. Click '+ Add tag' below the thumbnail in the sidebar this brings up, type your tag then press Enter. It will then appear under the Tags heading 1.

Searching 'Greece' shows everything from your trips; '2022' shows photos taken that year (in Greece or elsewhere); and 'bestofgreece' filters everything other than your favourite shots from those trips. OneDrive shouldn't count images twice, as they've never been in an album.

Move your photos to another service

If this doesn't suit you, and you don't want to upgrade to a paid-for OneDrive account, you could transfer to a different online-storage provider. Mega (**www.mega.io**) is one of the most generous. It gives you 20GB free storage, and is strong on privacy. Your files are encrypted, and only you have the keys to unlock them; not even Mega can see what you're uploading.

There is a catch: it limits the rate you can download your data at once it's on its servers. We're not sure what the limit is – Mega says it depends on your location and how many people are using the network. It also takes into account how much data you've downloaded in the past six hours.

There may be times when if you want to download a large number of photos, you have to wait six hours for the download to complete. Then, the transfer will resume automatically.

We'd be surprised if this were to affect anyone browsing their pictures online, which is how we'd recommend using any

online service for photo storage.

Transferring your photos to the cloud and not keeping a local copy or backup is risky, because you only need to get locked out of your account to lose years of memories. We advise keeping your photos on a local hard drive for everyday use and uploading a copy to the cloud for safekeeping.

If you're an Amazon Prime member, you could take advantage of the free unlimited storage for high- resolution photos for as long as you keep your account (for non-Prime members, storage is capped at 5GB, as it is with the free version of OneDrive). You can sign into Amazon Photos at **tinyurl.com/5wda7s9c**.

Export your photos from OneDrive

Wherever you want to move your photos to, your first step is to export them from OneDrive. The easiest way to do this is to sync your online folders to your local PC. That way, your photos will be copied to your local Pictures library, from which you can upload them directly to your new online-storage service.

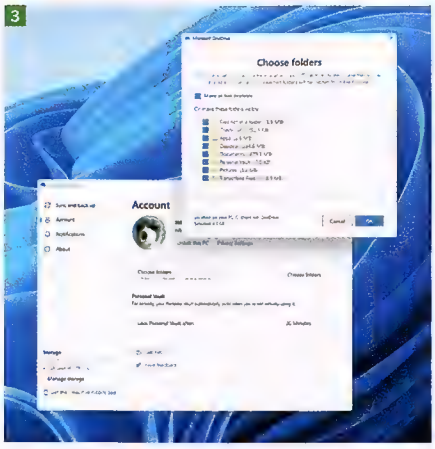
Open File Explorer and look for your OneDrive account in the sidebar 2. Expand yours by clicking the arrow to the left of its name, and check that the Pictures folder appears.

To sync your PC and OneDrive Pictures folders, click the OneDrive icon on the Windows taskbar, then click the cog at the top of the pop-up window, followed by Settings. Click 'Account' on the left 3, followed by 'Choose folders' in the main part of the window. Tick the box beside Pictures and any other OneDrive folder that you want to synchronise to your PC. Click OK, and Windows will download their contents from the cloud.

If you're not logged into OneDrive on your PC, you can download your photos through your browser. Log in at **www.onedrive.com** and click Photos in the sidebar. Next, hover over your most recent photo, and a small circle will appear in the top-right corner. Click this to select the photo without opening it.

Scroll to the end of the library and hold Shift while hovering over the last photo. All the other photos that fit into the window will be shaded, and a circle will appear on the last one – click in it. Click the Download link that appears in the floating bar at the top. Your image library will be compressed and downloaded.

3



Upload your photos to Mega

Like OneDrive and Dropbox, Mega has its own app, which synchronises files between your computer and the cloud. Download it by clicking 'Download MEGA Desktop App' from mega.io/desktop. Once it's downloaded, launch the 'MEGAsyncSetup64' file from your Downloads folder 4, and leave the options in their default settings. Leave the option to 'Run MEGAsync 4.9.6' (or later) selected and click Finish.

If you've already created a Mega account through the website, click 'Log in' and provide your credentials. If not, click 'Create account' and enter the required information. It will send an email to your inbox – click the 'Activate account' link it contains.

Log in using the credentials you provided during installation, and Mega will create the encryption keys for your account before showing you the membership options. Scroll down and click 'Get Started for Free'. Mega will take a moment to build a file list, then show your account-recovery key, which you'll need if you forget your password. Click the green Download button, and save it.

Return to the Mega setup assistant and log in using the credentials you just confirmed. It will ask which folders you want to synchronise. Click 'Selective sync', followed by Next. On the following screen, click Change on the line next to 'Local folder', and navigate to your Pictures folder in the File Explorer window.

Be careful if you have set OneDrive to synchronise your Pictures folder, as you may have two of these: one in your user folder, and one inside your OneDrive folder. You want to use the former of these to avoid uploading another copy of your photos to your OneDrive account.

Click Local Disk in the sidebar, followed by Users in the window. Click your name, followed by Pictures. Click 'New folder' above the sidebar, and call the new folder 'mega'. Double-click the new folder, then Select Folder. Click 'Next' in the Setup assistant window, then Finish.

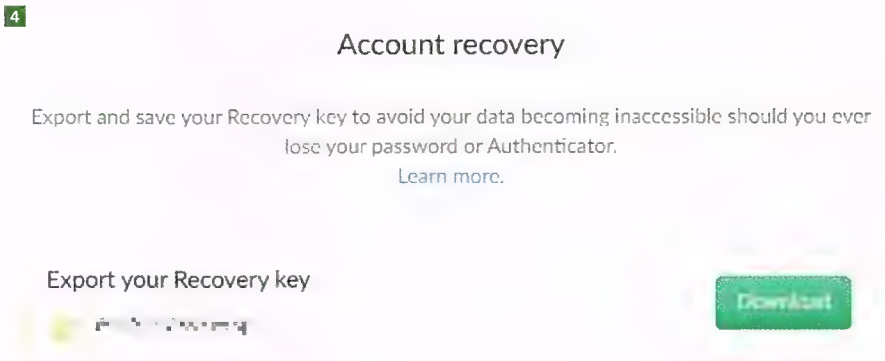
Open File Explorer. If you downloaded your photos from OneDrive through the browser, navigate to your Downloads folder, then unzip the OneDrive archive containing your photos. Open the folder. If you're syncing your photos to your PC, navigate to the Pictures folder in the OneDrive section in the File Explorer sidebar.

Whichever folder you're in, select all the files (Ctrl+A), then copy them (Ctrl+C). Scroll down the sidebar until you find 'mega', then click it and press Ctrl+V to paste a copy of your photos into it. They will be uploaded to the Mega servers in the background.

While you can open your synced photos via File Explorer, you can also access them remotely through the browser. Switch back to www.mega.io in your browser and click Photos in the sidebar to find the photos you've uploaded. If you do this too quickly, you may find they're still uploading, so don't worry if they don't all show yet.

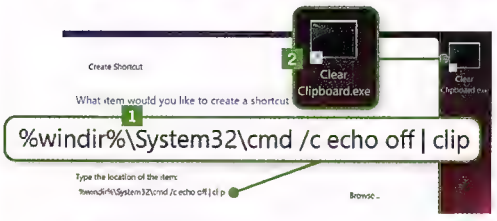
To create an album for related photos, click Albums, then 'New album'. Give it a name, and Mega will ask which photos to add. Click on the images, then click the green button marked Add. ■

4


Account recovery
Export and save your Recovery key to avoid your data becoming inaccessible should you ever lose your password or Authenticator.
Learn more.
Export your Recovery key
Download

Make Windows better

Expert tips for a better experience.



WINDOWS 10 & 11

Create a shortcut to clear your clipboard

If you cut or copy a lot of items to your clipboard, you may accidentally paste the wrong thing from time to time. Consider creating a desktop shortcut on Windows that lets you easily remove all items from your clipboard, without first needing to tap the Win+V shortcut to access the Clipboard menu.

First, right-click anywhere on your desktop and hover over New, then click Shortcut. Now type %windir%\System32\cmd /c echo off | clip (1 in our screenshot below – copy and paste this from **pastebin.com/suZMCQZu**). Click Next, type a name for the shortcut, then click Finish. Your new shortcut will appear on your desktop as an EXE file 2. Double-click it any time you want to remove all items from your clipboard.

WINDOWS 10 & 11

Turn tools on/off using PowerToys dashboard

Version 0.75 of PowerToys, released in early November, has a new dashboard that lets you turn tools on and off without having to go into settings. If you've not updated PowerToys to 0.75, open the program then click 'Install now' in the green box. If you've not installed PowerToys at all, do so from the Microsoft Store: **tinyurl.com/APC529pt**.

Now open PowerToys, then click Dashboard at the top left (1 in our screenshot below left). The dashboard will show all 'Enabled modules' (ie, tools) 2 at the top and 'Disabled modules' 3 below that. Click the slider next to any tool to activate/deactivate it.

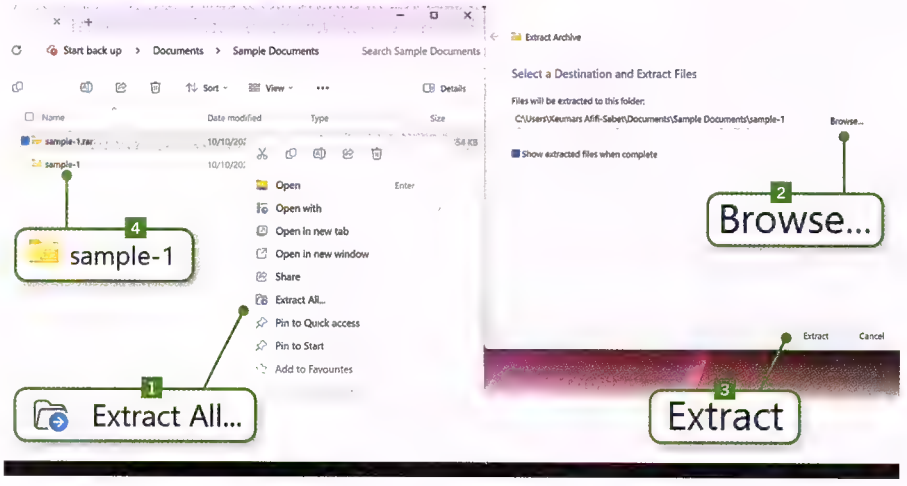
Windows 11

Extract RAR files without using software

New in the Windows 11 23H2 update is support for extracting RAR files without having to use third-party software such as WinRAR.

To do so, right-click your RAR file then click 'Extract All...' (1 in our screenshot). A new window will appear prompting you to choose a location for the uncompressed folder. By default, this is set to the same destination in which your compressed folder is stored, but you can click Browse 2 to change the file path.

Next, click 'Extract' 3 when you're ready, and the uncompressed file will appear in File Explorer 4.

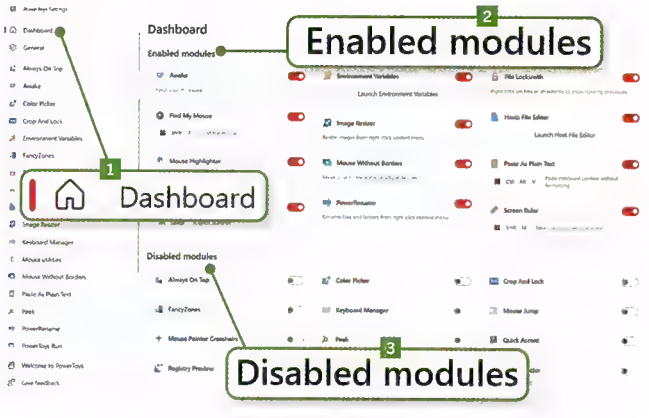


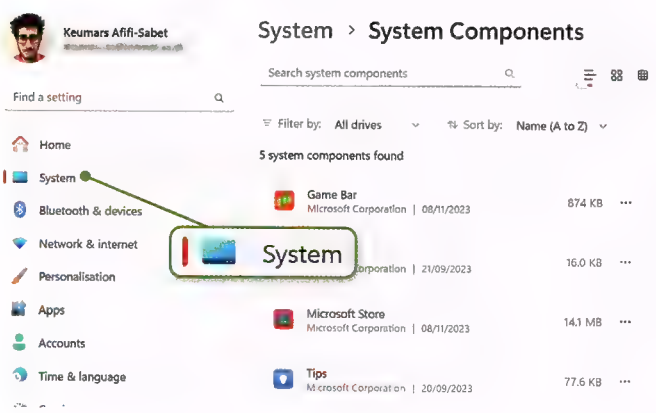
WINDOWS 11 INSIDER

View system components in one place

Microsoft wants to separate apps that come pre-installed on Windows (ie, system components) from those that you install yourself. Currently, both types are shown when you open Settings and click Apps then Installed Apps. However, in build 22635.2552 – available to Windows Insiders on the Beta channel – built-in apps have been removed from the Installed Apps section, and now only appear listed as System Components.

You can see these by clicking System on the left (see screenshot below). Next, scroll down and click System Components and you'll see apps including Game Bar, Get Help and Tips. Note that it's a work in progress, so not all built-in tools are included yet. ■





Make Office better

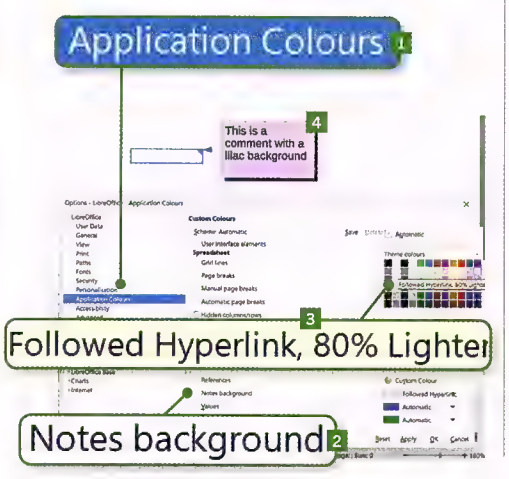
Expert tips for a better experience.

LIBREOFFICE CALC

Change the background colour of comments

When you leave a comment on a spreadsheet in LibreOffice Calc, you'll notice the background is set to a pale yellow by default ('Accent 5, 80% Lighter'). Version 7.6 of LibreOffice adds a setting that lets you change this to another colour

Click 'Tools' in the toolbar, then Options. When the window appears, click Application Colours (1 in our screenshot below). Then, in the main window, scroll down until you see 'Notes background 2', under Spreadsheet. Click the button to the right, which shows Automatic by default, then pick a new colour – we chose lilac ('Followed Hyperlink, 80% Lighter') 3. To confirm, click Apply, then OK. Our comment 4 changed its background colour to reflect our choice.



ONLYOFFICE

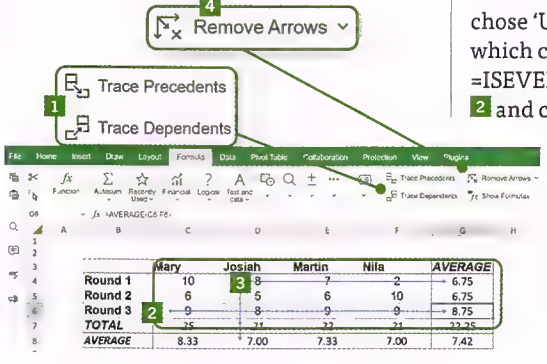
Use arrows to see how your formulas work

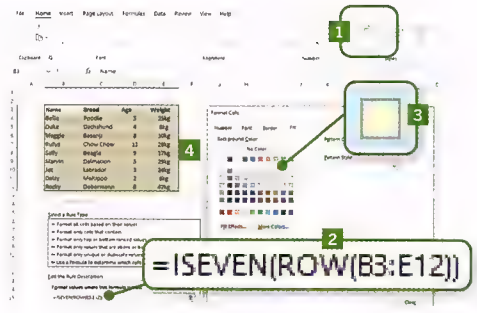
OnlyOffice version 7.5 added Trace Dependents and Trace Precedents settings (1 in our screenshot below) that use blue arrows to show which spreadsheet cells are covered by the formulas you enter.

To see these arrows, click the Formula tab, followed by a cell that contains a formula, then Trace Precedents. In our example, we clicked G6 and a blue arrow appeared running across cells C6, D6, E6 and F6 2 – because all four cells are used in the =AVERAGE formula we had typed into G6.

The Trace Dependents option shows which cells are mentioned in formulas typed into other cells. We clicked D4, and blue arrows appeared pointing to D7, D8 and G4 3, because they all have formulas that mention D4.

Click Remove Arrows 4 to return to your normal view.


4
Remove Arrows
Trace Precedents
1
Trace Dependents
Round 1 10 3 8 7 2 6.75
Round 2 6 5 6 10 6.75
Round 3 2 9 8 9 9 8.75
TOTAL 25 21 22 21 22.25
AVERAGE 8.33 7.00 7.33 7.00 7.42



MICROSOFT EXCEL

Use ISEVEN to make table rows alternate colours

You can use the =ISEVEN and =ISODD functions to determine whether values in your data are odd or even, because they normally give a TRUE or FALSE value. But you can also use them to alternate table-row colours.

We highlighted cells B3:E12 to select our table, then clicked the Conditional Formatting dropdown button (1 in our screenshot above) in the Home tab.

We clicked 'New Rule...' to open the New Formatting Rule window, then chose 'Use a formula to determine which cells to format'. We typed =ISEVEN(ROW(B3:E12) in the text field 2 and clicked 'Format...', Fill, then chose pale yellow (Gold, Accent 4, Lighter 80%) 3 from the selection. We clicked OK on the Format Cells window, then OK on the New Formatting Rule window, and the even rows in our table turned yellow 4.

Libreoffice Writer & Microsoft Word

Select text with F8 on your keyboard

In Writer and Word you can press Ctrl+Shift plus your keyboard's arrows to highlight text in a document. Another option is to activate selection mode. This disables typing and lets you use several keyboard functions to highlight text.

First, press F8 to turn on selection mode. Press F8 once more to select a word from where your cursor is placed. Press it twice to select a sentence; three times to select a paragraph; and four times to select your whole document. In our screenshot, we placed our cursor at the start of the second paragraph and pressed F8 twice after turning on selection mode to highlight the first sentence.

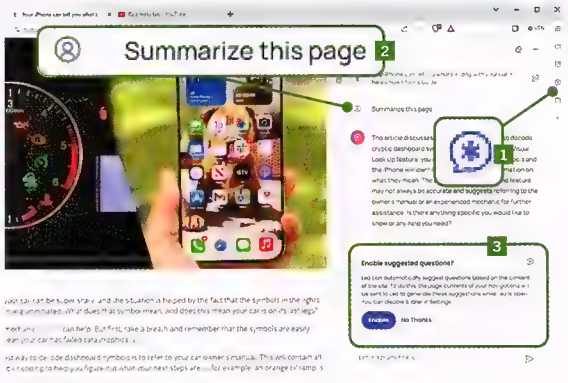
You can use the arrow keys to change your selection. Press Up or Down to change it between lines, or the Left and Right keys to change between characters. To exit selection mode, press Esc. ■

elements you want from the different galleries. Themes and styles also help keep your document coordinated. When you click Design and choose a new Theme, the pictures, charts, and SmartArt graphics change to match your new theme.

When you apply styles, your headings change to match the new theme. Save time in Word with new buttons that show up where you need them. To change the way a picture fits in your document, clic it and a button for layout options appears next to it. When you work on a table, click where you war to add a row or a column, and then click the plus sign. Reading is easier, too, in the new Reading

Browser tips

Secret settings and best extensions



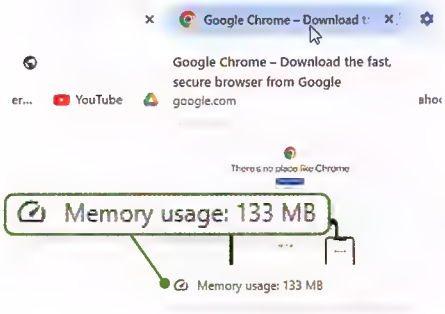
CHROME

Check the memory usage of your tabs

Back in February 2023, Google finally addressed one of the biggest problems with Chrome: the browser's excessive usage of system memory. A new 'Memory saver' feature, introduced in Chrome 110, stops the browser hogging RAM and slowing your PC, by automatically freeing up memory from inactive tabs.

To round off the year, Chrome 119 (released in November) adds the useful ability to check how much memory individual tabs are using. This means you can close any that are consuming too much RAM and that risk crashing your browser – or entire PC.

Simply hover your cursor over a tab and Chrome will display the 'Memory usage' in megabytes below the title and preview image of the web page (see screenshot below).


Google Chrome – Download t
Google Chrome – Download the fast, secure browser from Google
YouTube
google.com
There's no place like Chrome
Memory usage: 133 MB
Memory usage: 133 MB

If you can't see this information, you can enable the feature manually until it rolls out to your version of Chrome. To do so, type **chrome://flags** into the address bar and press Enter to load the Experiments page. Find the entry Show memory usage in hovercards, select Enabled in its dropdown menu and relaunch the browser.

In a less welcome change, Google has removed the experiment that let you disable Chrome's new 'download bubble'. This means your downloads now appear on a button in the browser's top-right toolbar, instead of in a bar along the bottom of the window.

See our Workshop below to find out how to restore the classic download bar.

BRAVE

Summarise the content of web pages using AI

Brave 1.60, which was released in November, introduces the browser's new AI assistant, Leo. We wrote about Leo in our 'What's All the Fuss About' section in Issue 666 and the chatbot is now available to all Brave users.

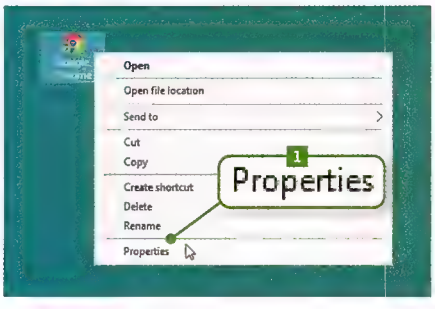
To launch Leo, click the new button in the browser's sidebar that looks like an asterisk in a speech bubble (1 in our screenshot above right). This opens a side panel, where – after clicking 'Accept and begin' – you can interact with the assistant. Brave says Leo is more private than rival chatbots because it doesn't store or share details of your queries.

As well as asking Leo to look up information online, and generate content based on text prompts, you can get it to summarise the current web page. Click the 'Summarize this page' button 2, or type that command into the text box, and Leo will provide an overview of what the article is about. Enable 'suggested questions' 3 and the chatbot will suggest further questions you might want to ask.

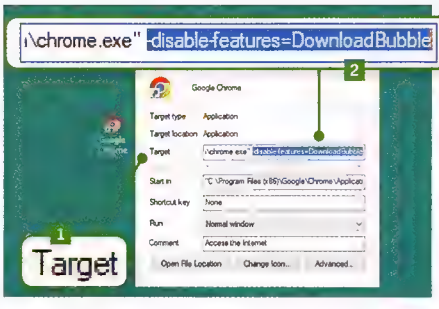
The 'Summarize' feature is also supposed to work with online videos, but this aspect seems to be still in development. When we asked Leo for a synopsis of a video about fixing a leaky tap, it told us the clip was about "practising self-care to avoid burnout".

If Leo doesn't interest you, remove it from Brave's sidebar by right-clicking its button and choosing Remove.

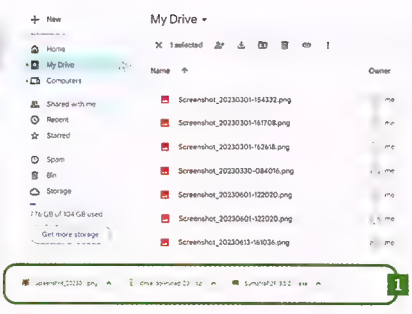
Workshop Restore the classic download bar in Chrome



Right-click your desktop shortcut for Chrome and choose Properties 1. If you don't have a shortcut for the browser, you can create one by dragging the Google Chrome entry from the Windows Start menu to your desktop.



When the Properties box opens, add the following to the end of the Target field 1, separated by a space: -disable-features=DownloadBubble 2. You can copy and paste this from our Pastebin account at **tinyurl.com/APC529bin**.



Click 'OK' and close any open Chrome windows. Double-click the shortcut to launch the browser and when you download a file, the bottom download bar should be restored 1. Pin the desktop shortcut to your taskbar for easy access.

Best extension for... Replacing the background of photos

BG REMAKER

Chromium

tinyurl.com/APC529bg

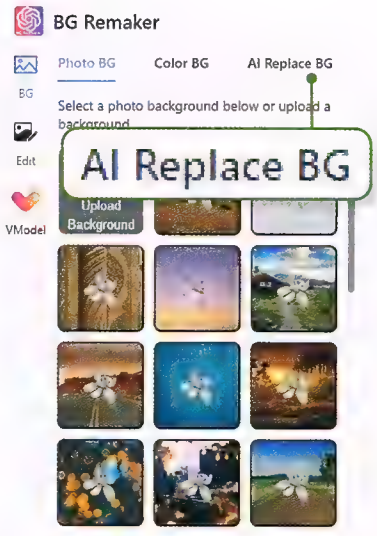
There are many tools for replacing the background of images, but you usually need to pay for unlimited use. BG Remaker lets you perform this task directly in your browser for free. Install the extension, then upload either a portrait photo or a product shot. BG Remaker will use AI to identify the subject and remove the background, without you needing to click anything, though you can use the Refine Background tool to make necessary adjustments. The add-on provides dozens of alternative backgrounds, featuring photos or solid colours, which can be applied with a single click. You can also use the AI Replace BG tool to generate a background based on a text prompt or template. When you've finished, click the Download button to save your image with its new background.

IF YOU DON'T LIKE THAT, TRY...

REMOVE BACKGROUND FROM IMAGE

tinyurl.com/APC529rb

This extension is even simpler to use than BG Remaker, but it doesn't offer as many alternative backgrounds or the option to generate your own.



EDGE

Split your screen vertically or horizontally

Microsoft has made plenty of changes to Edge this year – some more welcome than others – and one of the most useful is the browser's 'Split screen' mode. This lets you view two tabs side by side in the same window, so you can browse two pages simultaneously, without needing to switch between tabs.

Edge 119, released in November, expands the 'Split screen' feature with a 'vertical view' option. This displays one tab on top of the other, rather than side by side. As with the standard 'Split screen' mode, which is now called 'horizontal view', you can either load separate web pages in each half of the browser, or connect the split tabs so that when you click a link in one, it opens in the other.

To try the feature, click the 'Split screen' button on Edge's toolbar to divide your current tab in two, then open a web page on the right-hand side. Hover your cursor over the top-right corner and click the three-dot 'More options' button that appears. Select 'Switch to vertical view' to stack your split tabs – confusingly, this displays pages horizontally!

To open links from the top tab in the bottom one, choose 'Link tabs' in the 'More options' panel. This also lets you switch the 'up and down' tabs, open a page in a new (unsplit) tab and either go back to horizontal view (see screenshot below left) or exit 'Split screen' mode.

FIREFOX

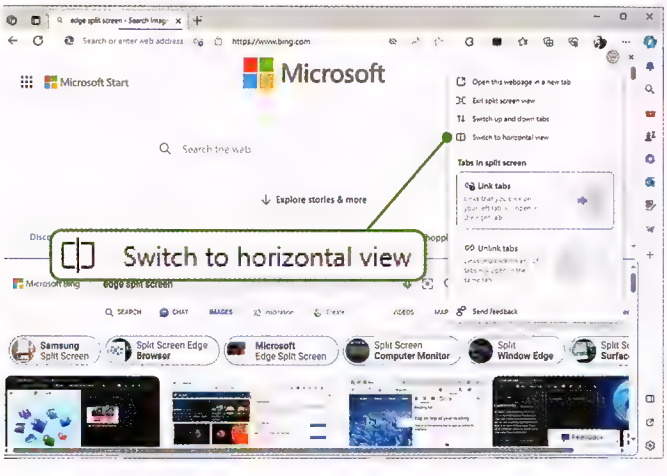
Delete your session data in private mode

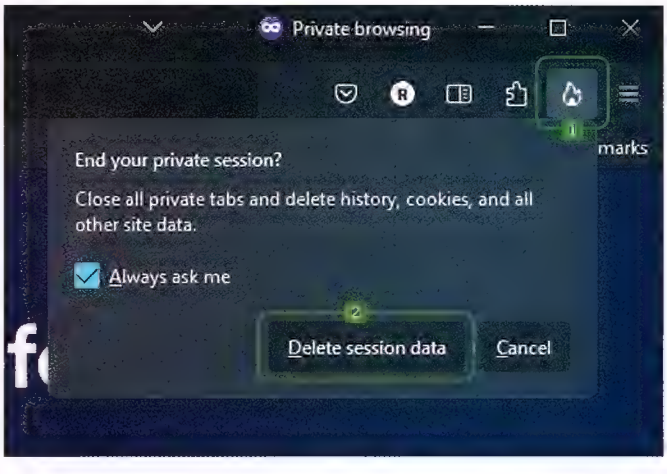
One of our favourite features in DuckDuckGo's browser (**https://duckduckgo.com**) is the Fire button, which lets you close your open tabs and delete your browsing data in one click. Firefox 120, released at the end of November, introduces a similar option in the browser's private mode.

Although private mode is supposed to stop your browser storing details of the sites you visit, it's not completely reliable and some of this data may be leaked. Firefox's new feature ensures this doesn't happen by closing all your private tabs and deleting your browsing history, cookies and other site data.

To use it, open a private window by pressing Ctrl+Shift+P or by selecting 'New private window' in the main Firefox menu. When you've finished browsing privately, click the End Private Session flame button on the toolbar (1 in our screenshot below) and choose 'Delete session data' 2. Untick the box 'Always ask me' to perform the deletion in future without prompting you.

If you can't see the flame button in private mode, type about:config in the browser's address bar, press Enter and click 'Accept the Risk and Continue'. Find the preference **browser.privatebrowsing.resetPBM.enabled** and double-click it to change its value to 'true'. Restart Firefox, open a private window and you should now see the End Private Session button. ■




Private browsing
End your private session?
Close all private tabs and delete history, cookies, and all other site data.
Always ask me
Delete session data
Cancel

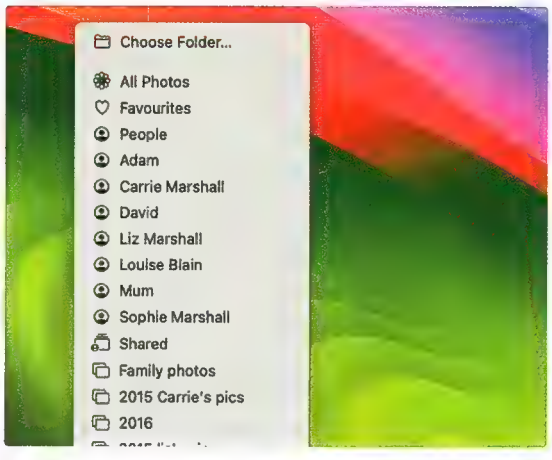
Customise your desktop

Make your Mac look great at any point in the day with these easy tweaks.

IT WILL TAKE
10 minutes
YOU WILL LEARN
How to customise your Mac's wallpaper and screen saver

YOU'LL NEED
macOS 14 or later

One of our very favourite things about macOS Sonoma is that more than ever before, you can make your Mac perfectly you. So you can have iPhone-style (or for older Mac users, Mac OS X Tiger-style) widgets on your desktop and Apple TV-style aerial screen savers to turn your display into an atmospheric view of incredible landscapes, dramatic skylines and beautiful natural scenes.



If you tap on Add Folder or Album, you can choose from the People smart album as well as your other Photos albums.

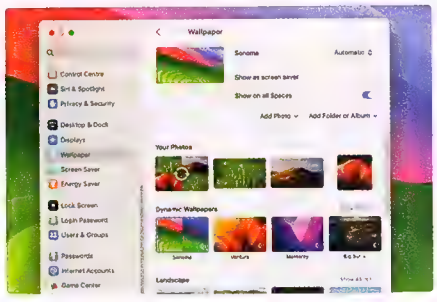
In this tutorial, we're going to concentrate on two simple but really effective tweaks that make your Mac look brilliant in any room. The first is your wallpaper, which is the image or colour that lives on your Mac desktop behind your icons and your apps; this can be static, or it can change as the hours or days change. And the second is the screen saver, which is the image or video that displays when your Mac has been sitting idle for a while; you can set how long in Settings > Lock Screen.

Looking good

Although screen savers were initially designed to prevent burn-in, which used to leave a ghostly shadow on the screens of old cathode ray monitors if they showed the same thing all day long, today they're much more about simply keeping your Mac display looking good when you're doing something else or just having a think or well-earned break. And, as we'll discover in this tutorial, the selection of screen savers in macOS Sonoma is the best looking, most comprehensive and most entertaining selection yet.

Carrie Marshall.

How to Make your Mac perfectly you

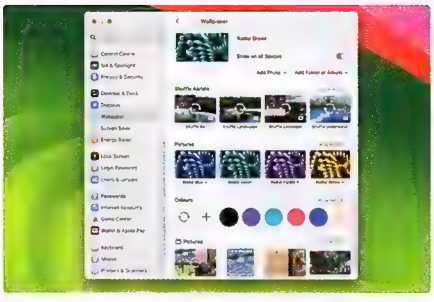


1 Open Settings

To find Wallpaper settings, go to Apple menu > System Settings > Wallpaper. The currently selected wallpaper appears at the top; you'll see other available ones as thumbnail images below. Simply click on the one you want to select it.

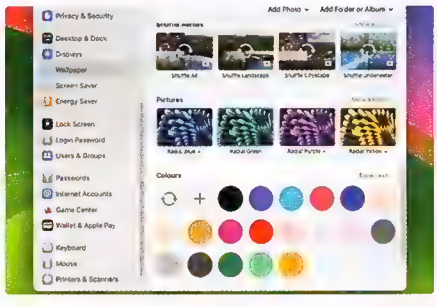
2 Set the darkness

With dynamic wallpapers, colours change depending on the time of day or whether your Mac is in dark/light mode. To override the defaults, click on the menu (top right): the default is Automatic but you can select Light or Dark.



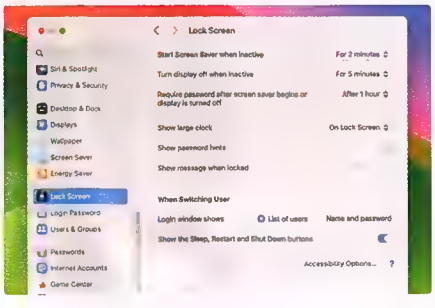
3 Scroll further down

As you can see, there are lots of different options here ranging from abstract shapes to aerial views of cities and landscapes. If you select a Shuffle Aerials option, the image will change according to the schedule you select.



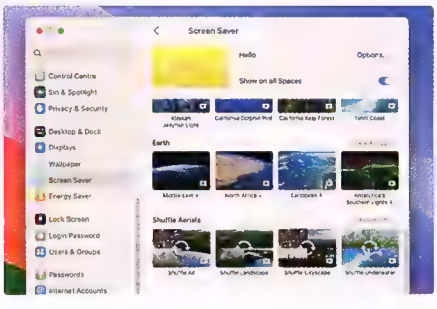
4 Choose a colour

If you're not fussy about having a nice photo and would rather just have a solid block of colour, you can do that: just scroll towards the bottom of the Wallpaper options and you'll see a range of colours to choose from.



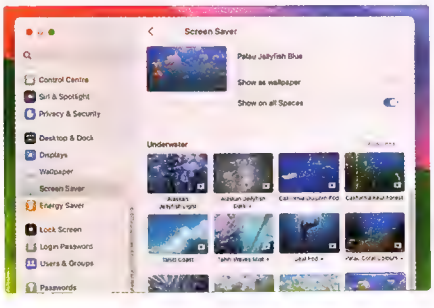
5 Set your timer

Before you pick a screen saver, use the sidebar to access the Lock Screen settings panel. Here you can tell your Mac when the screen saver should begin. Your Mac will tell you if your chosen setting conflicts with your sleep settings.



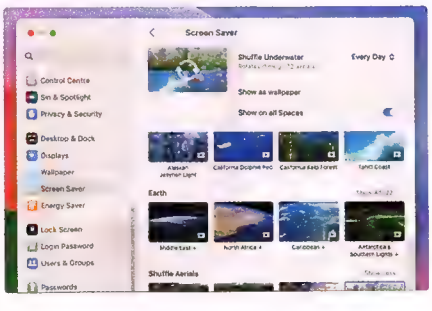
6 Explore the options

Using the sidebar, select Screen Saver and you'll see a collection of screen savers – there's a huge variety. To preview one, select it then tap the Space bar. Some more complex screen savers may need to download first.



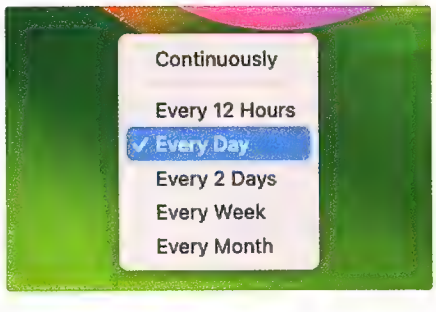
7 Set a destination

You'll see 'Show as wallpaper', which uses a static version as your background, and 'Show on All Spaces'. If you have multiple spaces set up in Mission Control, you can choose to show your screen saver on some but not all of them.



8 Shuffle your saver

Scroll down to Shuffle Screen Savers. These are themed collections that'll move from screen saver to screen saver at the frequency you select. For example, Shuffle Underwater provides a selection of underwater scenes.



9 Set the frequency

You can adjust the frequency of your shuffle screen saver by selecting the menu towards the top right of the panel. Your choices range from changing the screen saver every 12 hours to changing it once a week or once a month. ■

Safeguard your secrets

Shashank Sharma gets a taste for 007's life by reading fiction and occasionally sending encrypted messages to his unsuspecting brother.

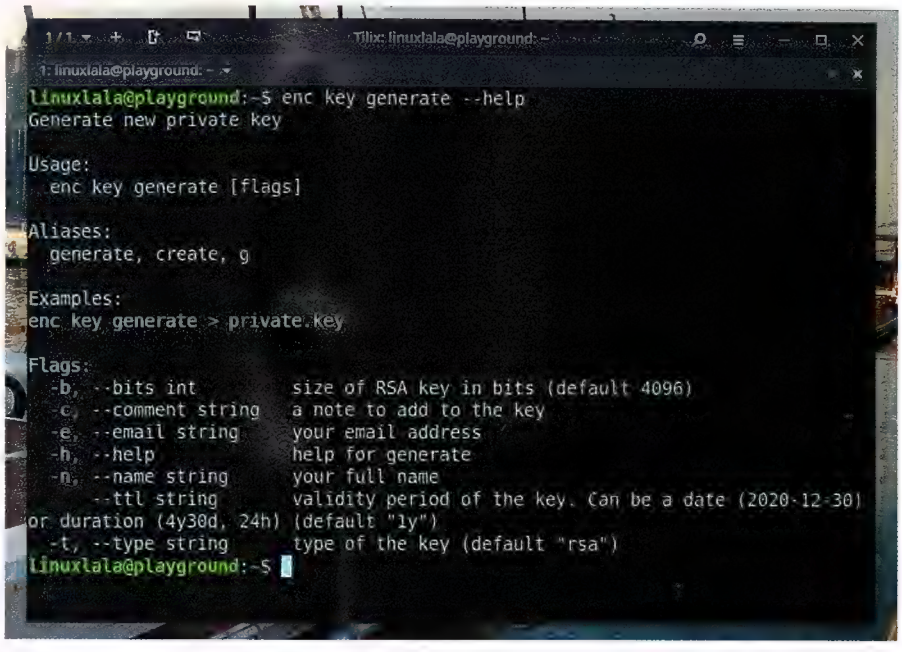
Some messages are just too private to be shared directly with the recipient. Although the need might not arise often, it's imperative that you know the right encryption tool if you want to share messages privately. But the word encryption conjures a jumble of other words, such as algorithms, ciphers, salts, public and private keys, and so on, which might seem like a little too much trouble to master when all you want to do is organise a surprise party for a beloved boss's retirement.

Enc bills itself as a modern and friendly alternative to GnuPG, which has long been the torch bearer for encryption across Linux and Unix systems. Released under the MIT licence, Enc is not as robust as GnuPG, and does not aim to be a stand-in replacement for it in every instance. In fact, Enc is designed with the classic Unix philosophy of 'doing one thing well' in mind. To that end, Enc can be used to encrypt messages. And that's it. Of course, the message could be stored in a text file and encrypted in a myriad of ways, such as passwords or keys.

While GnuPG is part of the software repositories on most distributions and is often part of the default installation, you have to install Enc manually. Thankfully, the process is quite straightforward. If you already have Go installed on your system, you can run the `go install github.com/life4/enc@latest` command to install the latest release.

Alternatively, you can download the latest source tarball from the project's GitHub page (**https://github.com/life4/enc/releases**), run the `tar -xf enc_<version>_<release>.tar.gz` command, and move the extracted binary to any directory in your $PATH:

```
$ cd Download/projects
$ mkdir enc
$ mv enc_1.1.2_linux_x86_64.tar.gz enc
$ cd enc
$ tar xvf enc_1.1.2_linux_x86_64.tar.gz
$ ls
enc enc_1.1.2_linux_x86_64.tar.gz
LICENSE README.md
$ chmod +x enc
$ sudo mv enc /usr/local/bin
```


Tilix: linuxlala@playground: ~
1: linuxlala@playground: ~
linuxlala@playground:~$ enc key generate --help
Generate new private key
Usage:
enc key generate [flags]
Aliases:
generate, create, g
Examples:
enc key generate > private.key
Flags:
-b, --bits int size of RSA key in bits (default 4096)
-c, --comment string a note to add to the key
-e, --email string your email address
-h, --help help for generate
-n, --name string your full name
--ttl string validity period of the key. Can be a date (2020-12-30)
or duration (4y30d, 24h) (default "1y")
-t, --type string type of the key (default "rsa")
linuxlala@playground:~$

Almost all commands in Enc have a shorter alias to help you save time by not having to type the complete command.

Unlike most other utilities, which extract files into a dedicated directory, you have to manually create a directory and move the tarball to it, before extracting files. Next, we make the enc binary executable, and finally we move into a directory in the $PATH, in this case the /usr/local/bin directory.

Tell me a secret

The basic workflow when working with Enc is that you use the `enc encrypt` command to encrypt your message or text file with a password. When you want to read the file or message, you have to decrypt the encrypted binary file using the same password and the `enc decrypt` command.

Let's create a text file with a message that we wish to keep secret from prying eyes with the `touch secretfile.txt` command. You can now use your favourite text editor to add some content to this newly created file, and save it.

```
$ cat secretfile.txt | enc encrypt
--password 'some-clever-password' >
encryptedfile.bin
```

In this example, we've used the `enc encrypt` command to safeguard the message using a password. To decrypt the file, we now use the `enc decrypt` command, as you'd expect:

```
$ cat encryptedfile.bin | enc decrypt
--password 'some-clever-password'
This is a test text file.
It will be deleted once the tutorial is done.
```

As you can see, the content of the encrypted file is displayed on screen when you provide the correct passwo
The Enc utility reports an error if yo
type the wrong password:

```
$ cat encryptedfile.bin | enc decrypt
--password 'same-clever-password'
Error: cannot decrypt message: go
error in reading password protect
message: wrong password or m
message
```

> "Enc bills itself as a modern and friendly alternative to GnuPG, which has long been the torch bearer for encryption across Linux and Unix systems."

Because of the way the content of a file or message is directed to enc encrypt and enc decrypt, the Enc utility can only work with text files or text messages.

You don't always have to place your secret message in a text file before redirecting it to enc encrypt:

```
$ echo 'this message will not self destruct no matter how long you wait' | enc encrypt --password 'genius-password' > encryptedfile.bin
$ cat encryptedfile.bin | enc decrypt --password 'genius-password'
this message will not self destruct no matter how long you wait
```

By default, Enc displays the decrypted message on the screen, but you can divert it to an output file instead if you prefer with the cat encryptedfile.bin | enc decrypt --password 'genius-password' > decryptedmsg.txt command.

Some apps and utilities don't support sharing encrypted files. If you ever have to pass an encrypted file through such an application, you can disguise the encrypted binary as a text file, using enc armour:

```
$ cat encryptedfile.bin | enc armor > armoured.txt
$ cat armoured.txt
-----BEGIN PGP MESSAGE-----
Version: enc 0.1.0
Comment: https://github.com/life4/enc
wy4ECQMIkWbWtibgOXbgl5zqkjHp500R
XIKPC5HZ4x120nEBPndO49+iotHu+B4G
ozpFjBfBETgMEQMfT9ymz7F8 VPXy3JhJ
ziE9QbHH+ToyLQspUNfMQ3MMykKSBb
VIlj44
OxpMh0H5x0SRojSD1U/stnKf0g===X2Ly
-----END PGP MESSAGE-----
```

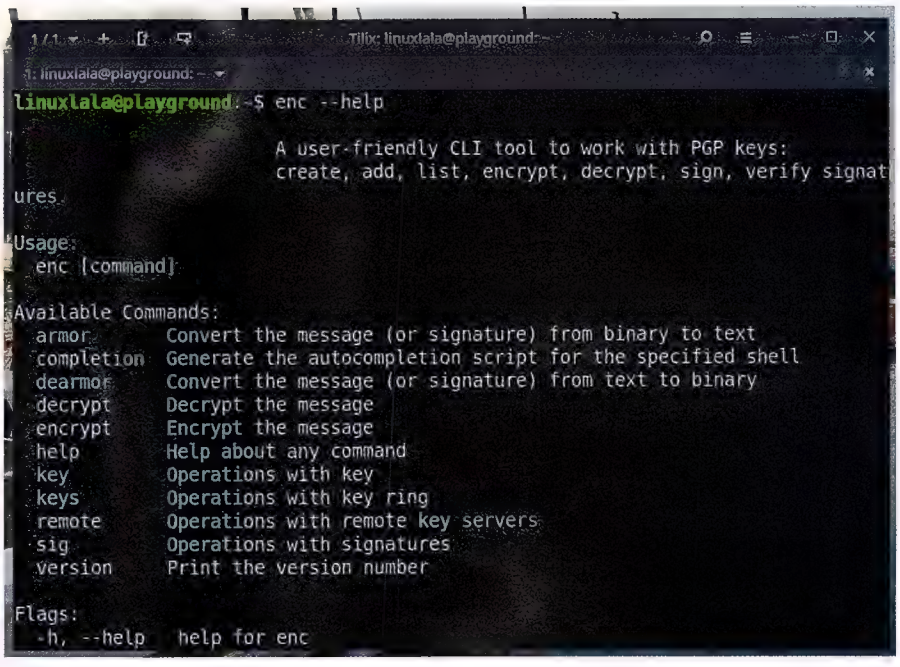
Note that the subcommand is armor. You have to decrypt the armoured file to read the secret message:

```
$ cat armoured.txt | enc decrypt --password 'genius-password'
this message will not self destruct no matter how long you wait
```

The project's GitHub page (**https://github.com/life4/enc**) has some useful pointers on how you can get past having to type your secret passwords as part of the terminal command, which can then be read by accessing the Bash history.

Working with keys

The other aspect of encryption is that it can be used to allow others to send you secret messages that can only be decoded by you. This is done by sharing with the world a public key, such as on your website or on your social media page. All secret messages intended for you are encrypted using this public key. Such messages can only be read by decrypting them using your private key.


Tilix: linuxlala@playground: ~
1: linuxlala@playground: ~
linuxlala@playground:~$ enc --help
A user-friendly CLI tool to work with PGP keys:
create, add, list, encrypt, decrypt, sign, verify signatures.
Usage:
enc [command]
Available Commands:
armor Convert the message (or signature) from binary to text
completion Generate the autocompletion script for the specified shell
dearmor Convert the message (or signature) from text to binary
decrypt Decrypt the message
encrypt Encrypt the message
help Help about any command
key Operations with key
keys Operations with key ring
remote Operations with remote key servers
sig Operations with signatures
version Print the version number
Flags:
-h, --help help for enc
Run the enc --help command for a list of all the subcommands you can use with Enc.

To generate a private key, you must run enc key generate > private.key. This private key is valid for one year by default, and comprises a host of information such as your name, email address and so on.

You can provide custom values to the key, such as email, duration and so on. Run enc key generate --help to view all the definable parameters for the key.

The public key associated with the private key so generated can be extracted with the cat private.key | enc key public > public.key command.

To encrypt a message with the public key, you must run the cat file.txt | enc encrypt --key public.key > encrypted-with-key.bin command. This encrypted file can be read with the cat encrypted-with-key.bin | enc decrypt --key private.key command.

For additional security, you can also lock your private key with a password. This is recommended, in fact, otherwise anyone with access to your system and private key can read all private messages.

Run cat private.key | enc key lock --password 'password-for-private-key' > passwordlocked.key to password-protect your private key. To decrypt a message using the locked private key, run cat encrypted-with-key.bin | enc decrypt --key password locked.key --password 'password-for-private-key'.

Refer to the Getting Help box (below) for instructions on how you can learn more about Enc and its various subcommands. ■

GETTING HELP

The Enc project is limited in its functionality and doesn't aim to compete with GnuPG in terms of supported features. This enables the project to provide documentation on all of its limited feature set. The GitHub page walks you through the different aspects of using Enc, without inundating you with tech jargon.

Unlike most other GitHub-hosted projects, which have an easily accessible Issues page, Enc doesn't list this for some reason. You have to manually point your browser to **https://github.com/life4/enc/issues** if you wish to report an issue.

In any event, you can access help for each of the subcommands from the terminal itself, by using enc <command> --help. For instance, if you need to see an example usage of the enc armor command, or view the available flags, you can run enc armor -h.

Almost all the subcommands have a shorter alias, usually their first letter, but you can verify this by accessing the specific help page. For instance, to generate a private key, you would use enc key generate > private.key, but you can also use enc k g > private.key instead.

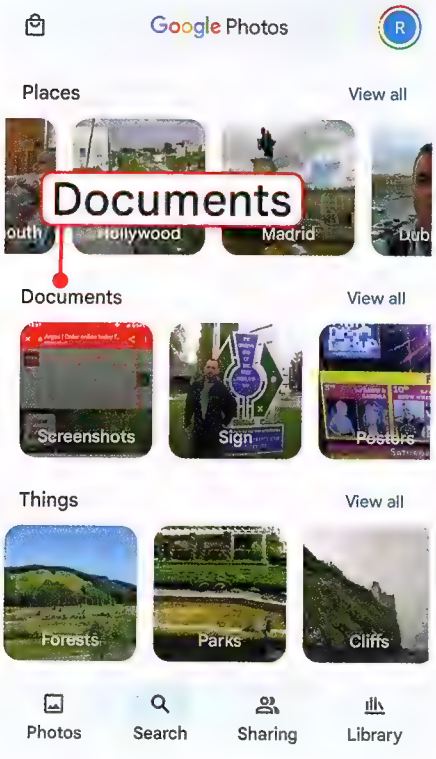
Phone & tablet tips

Brilliant things to do on your device.

ANDROID & iOS

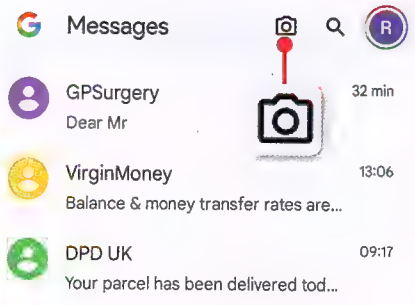
Find documents faster in Google Photos

The latest update to Google Photos improves the app's organisation of screenshots and photos you take of items containing text – including documents, posters and receipts. It now uses AI to better identify and categorise these images and sort them into appropriate albums. This makes it much easier to find text-based pictures without having to scroll through your whole photo library.



Tap the Search tab at the bottom of the Photos app and you'll see a new Documents section between the Places and Things rows (see screenshot below left). Here you'll find albums with labels such as Screenshots, Posters, Menus, 'Book cover' and 'Identity document'. If you find – as we did – that Google has placed some images in the wrong categories, tap the tick box next to them, then press the three-dot menu button and choose 'Remove photos'. You can optionally select a reason for removing the picture, to help the app improve its accuracy.

Google now lets you set reminders in your calendar from screenshots and photos that include dates of upcoming events. For example, if you have a screen grab of a train ticket or a picture of a concert flyer, tap 'Set reminder' to add the date to your calendar, and get a reminder nearer the time. You can also choose to automatically archive screenshots and documents after 30 days, which will hide them in your main gallery but keep them accessible in the relevant albums.



ANDROID

Capture photos through the Messages app

One of the benefits to using Google's RCS (Rich Communications Services) technology instead of standard text messages is that you can send people photos without being charged by your mobile network. To make things even easier, Google has updated its RCS-enabled Messages app with a camera function. The app comes installed on Android phones and is also available from the Play Store (**tinyurl.com/APC529msg**).

The new Camera button is located to the left of the search icon above your Messages inbox (see screenshot above). Tapping it opens the default camera app on your phone, so you can quickly take a photo. Now press the tick button to save the picture, and then select the person

Best new apps — What you should install this month

BREAK THE WEB

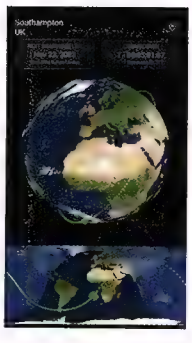
Free
iOS
tinyurl.com/APC529web

This AI-powered news app tells you which stories are 'trending' across the web and summarises their key points. It checks multiple sources from around the globe, and lets you choose Left or Right to read viewpoints from each end of the political spectrum. You can also track the coverage of topics over time.

BRING ME

Free
Android
tinyurl.com/APC529bm

Bring Me reminds you when and where you last had specific belongings, so you can quickly find them if they go astray. Add an item such as your wallet, keys or bag, then tap With Me to save the time and location. Choose 'Map View' to see the item on a map, mark it as At Home and add notes and a photo.



SPOT THE STATION

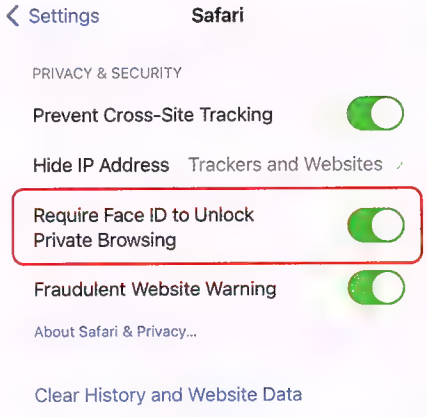
Free
Android
tinyurl.com/APC529ss
iOS
tinyurl.com/APC529ssi

Following the relaunch of NASA's main mobile app, this new app lets you track the International Space Station (ISS). Allow it access to your location, and the app will start a countdown to the next potential sighting. It shows you the station's trajectory on 2D and 3D global maps.

that you want to send it to.

The photo will be inserted in a message, so you can share it for free – provided both you and the recipient have RCS switched on. To check, tap your profile picture in the top-right of the Messages app and choose 'Messages settings', then 'RCS chats'.

Apple has finally agreed to support RCS on iPhones, so you should soon be able to send photos to iMessage users with no loss of quality or network charges.



iOS

Secure your private browsing in Safari

Like most browsers, Safari for iOS and iPadOS has a private-browsing mode that stops details of the websites you visit being stored on your iPhone or iPad. In iOS 17, the Private Browsing feature offers even more protection against prying eyes, both online and off.

It's now possible to lock your private tabs, so nobody but you can see the sites you've been looking at. To activate this option, open the Settings app, tap Safari and scroll down to the 'Privacy & Security' section. Switch on the option 'Require Face ID to Unlock Private Browsing' (see screenshot below) or 'Require Touch ID to Unlock Private Browsing', depending on which method you use to secure your iPhone or iPad. This means your private tabs in Safari can only be unlocked by using your face or fingerprint.

Private Browsing in iOS 17 automatically strips the tracking data from web addresses, so companies can't follow you around online (a feature recently added to Firefox). To apply this protection to standard browsing too, tap Advanced on the Safari screen in Settings, select 'Advanced Tracking and Fingerprinting Protection' and choose All Browsing.

Additionally, Safari in iOS 17 lets you change the default search engine in Private Browsing mode. Tap 'Private Search Engine' on the Safari screen and choose a more private option – preferably DuckDuckGo.

ANDROID & iOS

Add your email address to WhatsApp

WhatsApp has introduced the ability to associate an email address with your account. This enables you to access your WhatsApp account by entering your email addrthey have dozens of reviews on many category pagesess when you're in an area with no mobile signal, and can't use your phone number for verification.

To set up the new feature, tap your profile picture in the WhatsApp app and select Account. Tap 'Email address', enter your email and press Next. Type in the six-digit verification code that WhatsApp sends you and tap Verify (see screenshot right) to confirm.

At the time of writing, the 'Email address' option was available in the WhatsApp app for iOS and its beta version for Android – it should have rolled out to the stable version by the time you read this.

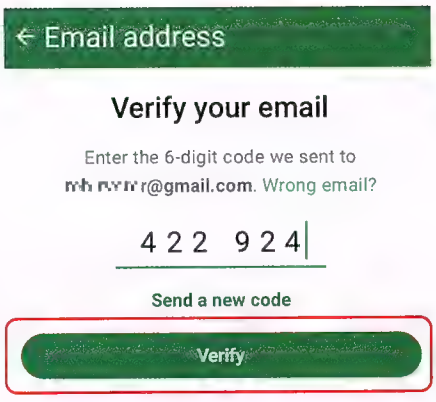
iOS

Share contact details instantly using AirDrop

To share a phone number or email address with someone, you usually need to send the details in a message, jot them down on a piece of paper or read them aloud. A new option in iOS 17 is more convenient than all those methods, letting you share contact details instantly.

It's called NameDrop and sends data from one iPhone to another using AirDrop, provided both devices have AirDrop enabled. Open the Settings app, choose General, then AirDrop and select 'Everyone for 10 Minutes' (see screenshot below).

Hold your phone near the top of the other person's iPhone, until a glow emerges from both devices to confirm they're connected. Once 'NameDrop' appears on both screens, choose the contact information you want to share and tap Share. This will send your details to that person, and vice versa – or they can opt to Receive Only. To cancel, move the iPhones away from each other before the transfer completes. Note that NameDrop only works for sharing new contact details, not updating an existing contact.



ANDROID & iOS

Hide your location during WhatsApp calls

WhatsApp has added a privacy feature that hides your IP address from people you call – or who call you – via the messaging app. This prevents them from deducing your geographic location, by routing the call through WhatsApp's own servers rather than connecting you directly to the other person. All calls remain end-to-end encrypted, though WhatApp says the new option will reduce call quality.

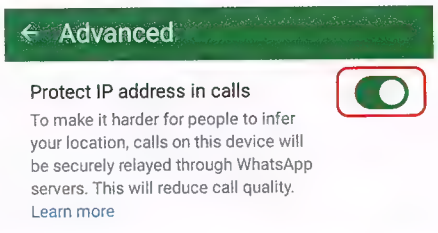
To activate it anyway, select Privacy in the app's settings, tap Advanced and switch on the 'Protect IP address in calls' option (see screenshot above). Turn it off again when speaking to people you trust.

ANDROID & iOS

Never lose your place in YouTube videos

There are plenty of new tricks to try in the YouTube mobile app. One tip we didn't have space forhaven't mentioned before lets you quickly go back to where you started after you fast-forward or rewind a video.

Previously, when you dragged the time slider left or right to start 'seeking' a specific moment in a YouTube video, it was tricky to return to where you left off – without closely examining the progress bar. Now, when you move your finger to the point where you began searching, your phone or tablet will vibrate, and you'll see a 'Release to cancel' message. Lift your finger to resume watching the video in the app. ■


Advanced
Protect IP address in calls
To make it harder for people to infer your location, calls on this device will be securely relayed through WhatsApp servers. This will reduce call quality.
Learn more

Take your Pi 5 to the next level!

Les Pounder has got his hands on a Raspberry Pi 5 and wants to show you how to get the best from it.

YOU'LL NEED
- Pi 5
- USB 3 to SATA/NVMe adaptor
- NVMe or SATA SSD
- Pi 5 Active Cooler

Your shiny new Raspberry Pi 5 is the fastest flagship Pi ever. But can we make it a little better? Sure we can, we just need to overclock it, boot from USB and make sure that it is adequately cooled.

In this tutorial, we will overclock the Pi 5 and show you how to install the new Raspberry Pi OS to a USB 3 drive. We'll also pass on a few pearls of wisdom from our weeks of testing and using the latest Pi.

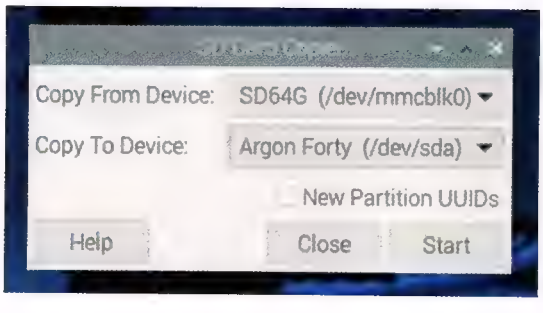
Cases and cooling

The official Raspberry Pi 5 case looks pretty much like the Raspberry Pi 4 model, except for the Ethernet port being switched to the other side of the USB ports, and the new case has built-in cooling. Yes, the Raspberry Pi 5 needs cooling. It can run without it but you will soon encounter CPU throttling. The official case has a tiny fan to blow cool air over the CPU, Wi-Fi and the new RP1 chip. It connects to the new fan connector, meaning that it has full access to the GPIO. We've got a case on order, as well as Pimoroni's new Pibow Coupe case for the Raspberry Pi 5.

For the best cooling, you will want to spend the extra $8.60 and pick up the Official Active Cooler. Looking resplendent in anodised aluminium, this cooler has a heatsink and active fan that connects to the CPU, Wi-Fi and RP1 chip via thermal pads. Held in place using new mounting holes in the Pi 5 PCB, the active cooler connects to the fan power connector. This fan cools extremely well and stays relatively quiet. We tested the original Pi 4 case fan and it sounded like tinnitus. The active cooler is quiet and only ramps up the speed when it really needs it.

At the time of writing, the official case and the active cooler are the only known cooling products for the Raspberry Pi 5. Reusing Raspberry Pi 4 coolers and cases will be problematic, largely down to the placement and removal of ports on the Pi 5. The composite jack has been removed and we now have two camera/screen connectors in its place. The USB and Ethernet ports have been swapped to their original locations (the Pi 4 changed them around) and this makes nearly all Pi 4 cases incompatible. The swap to micro HDMI ports means that Pi 3 cases are also incompatible. We did have a go at retrofitting a 52Pi Ice Tower cooler to the Pi 5. It worked, but we wouldn't suggest that you try doing this.

Long story short, buying the active cooler is a must, wait a while for a case.



Using SD Card Copier, we can clone our Raspberry Pi OS Bookworm install from microSD to a much faster USB 3/SSD combo.

Operating system

At the time of writing the Raspberry Pi 5 has just been launched, and for those who were quick off the blocks, their pre-orders are in the post. You need an operating system for your new Pi 5 and right now there are two choices. The official Raspberry Pi OS Bookworm release is a great desktop OS. Now based on Wayland, it feels slick and very grown-up, but it does have a couple of issues. Firstly, a change to the underlying Debian 12 distro means that installing Python modules via Pip is not possible at an OS level. PEP 688 details that we can no longer do this and we now need to use Python Virtual Environments (venv) in order to install our favourite Python modules. If you want to install Python modules at an OS level, use the Apt package manager. The second issue lies in the GPIO. Yes we can use the GPIO with Python, but we have to use GPIO Zero or get comfortable with lgpio. RPi.GPIO, the venerable Python module that powers the majority of HATs and Pi projects, no longer works with the Raspberry Pi OS. If you need to use a HAT, use an older Pi with Bullseye for now. Software support for your favourite HATs is coming, but still some time off.

The second OS choice for the Raspberry Pi 5 is Ubuntu 23.10, which has always been a good second-place OS in our eyes. It has always looked good and performed decently, but it had its own GPIO issues. With Ubuntu 23.10, we still have some HAT compatibility issues, but the GPIO is supported. Add the power of the Raspberry Pi 5's quad-core 2.4GHz CPU and Ubuntu 23.10 runs slickly.

Emulation-based OSes are still a work in progress; Recalbox has created a test version for the Pi 5, but your favourite emulator may not be supported yet.

Connecting the Raspberry Pi 5 to a USB SSD adaptor is simple and can be done for less than $10.

Overclocking a Pi 5

We've overclocked every model of Raspberry Pi and that now includes the Raspberry Pi 5. We've taken the CPU to 3GHz and the GPU (VideoCore VII 800MHz stock) to 1.1GHz!

Your results may vary, because the odds of the silicon lottery are never evenly stacked.

To overclock, firstly you need active cooling, so buy the active cooler before you attempt this.

In a terminal, open /boot/config.txt using Nano:

```
$ sudo nano /boot/config.txt
```

Scroll to the end of the file and add a new comment to identify where the overclock lines are:

```
# These lines overclock the Pi 5
```

Now add these two lines to overclock your Raspberry Pi 5 CPU and GPU to 2.8GHz and 900MHz respectively:

```
arm_freq=2800
gpu_freq=900
```

Why are we not going straight to 3GHz and 1.1GHz? We need to creep up to those speeds and ensure that our system is stable before we attempt a faster overclock.

Save the file by pressing Ctrl+X, then Y and Enter. Then reboot the Pi for the change to take effect.

To test the stability of the overclock, install Stress:

```
$ sudo apt update && sudo apt install stress
```

Run a five-minute stress test on all the CPU cores:

```
$ stress --cpu 4 -t 300
```

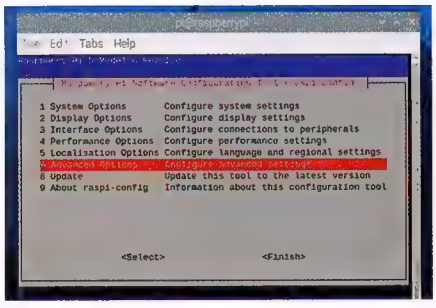
Open another terminal and use the `vcgencmd` command to monitor the CPU speed every second.

```
$ watch -n 1 vcgencmd measure_clock arm
```

Open a further terminal and use `vcgencmd` to monitor the GPU speed every second.

```
$ watch -n 1 vcgencmd measure_clock core
```

If you would like to learn even more about `vcgencmd` 00, you can head over to APC's sister site **www.tomshardware.com/how-to/raspberry-pi-benchmark-vcgencmd**, where you'll find detailed information to help you learn.


Tabs Help
1 System Options Configure system settings
2 Display Options Configure display settings
3 Interface Options Configure connections to peripherals
4 Performance Options Configure performance settings
5 Localisation Options Configure language and regional settings
8 Update Update this tool to the latest version
9 About raspi-config Information about this configuration tool
<Select>
<Finish>

The Raspi-config tool has more options than the Raspberry Pi Configuration GUI tool. It can help us tweak the system to meet our needs.

Booting from USB

The Raspberry Pi 5's microSD card speed i s phenomenal, but perhaps you would like capacity and speed at a lower price point? USB-to-SATA/NVMe adaptors provide easy access to cheap storage. We used an Argon One NVMe adaptor and a spare NVMe drive. Booting from microSD, we opened a terminal and launched the Raspi-config tool:

```
$ sudo raspi-config
```

Go to Advanced Options > Bootloader Options and select the latest Bootloader. This flashes the latest bootloader to the Raspberry Pi 5's firmware. You then need to reboot.

Go back into Raspi-config and select Advanced Options > Boot Order and select USB Boot. Don't reboot but close Raspi-config.

Connect your USB 3 drive to a USB 3 port and go to the main menu. Select Accessories > SD Card Copier.

From the app, select the source drive – this is your microSD card. The destination is the USB 3 drive. Click Start and the microSD card install is copied to the USB drive. This may take some time. When done, power off the Raspberry Pi 5, remove the microSD card and then power up again.

Your Raspberry Pi 5 just got a little bit faster and cooler, and has access to plentiful storage, and all it took was a handful of lines of code, some button presses and a few extra dollars. ■

POWER SUPPLIES

Any electronic device is useless without power and the Raspberry Pi 5 needs a good power supply. The official Raspberry Pi 5 PSU is the 27W USB-C power supply, and this custom-designed PSU has all the power we could need. Seriously, this USB-C PD PSU provides 5.1V at 5A – that's more power than a Steam Deck PSU (5V at 3A). The Raspberry Pi doesn't use anywhere near this much power, but when we start to add accessories, such as the hotly anticipated M.2 HAT, we will start to draw more power from the supply.

We recommend the official 27W PSU for the Raspberry Pi 5, though you can use the older Raspberry Pi 4 official PSU, but that is limited to 3A and you may start to see the dreaded 'lightning bolt' on your OS. Other power supplies can be used, but we would stick with supplies that deliver a true 5V output. USB-C PD supplies can be tricky. It is normally the responsibility of the device to negotiate the correct voltage, but if there is a mistake, your precious Raspberry Pi 5 may feel the sting, and so will your wallet.

You can also provide power via the GPIO, but we suggest that only experienced makers attempt this. You need to provide the correct voltage via a regulator and ensure there is enough current.

apc EDITOR'S CHOICE

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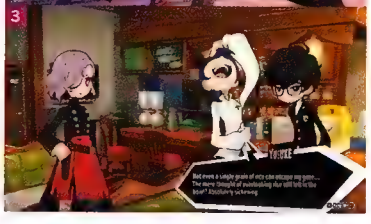
2



3

PRICE $94.95 **PLATFORM** PC, PS4/5, XB1/S/X, SWITCH **WEB** persona.atlus.com/p5t/

Persona 5 Tactica

The Phantom Thieves are back again to steal your hearts.

Though it's technically a spin-off by taking the characters from the hugely popular JRPG *Persona 5* and transporting them into a new genre and art-style, *Persona 5 Tactica* plays out more like a sequel, taking place directly after key story moments in *Persona 5*. Though it pares back or outright removes most of the slice-of-life elements of the series – attending classes, training your social stats, hanging out with your friends to raise your 'confidant' level, etc – that results in more space for focused, nuanced storytelling.

Combat in *Persona 5 Tactica* is reminiscent of the *XCOM* series, with a top-down grid layout and a focus on tactical gunplay. The twist to the formula is largely rooted in the One More mechanic, a holdover from *Persona 5* given a unique and extremely satisfying spin.

By either removing your enemies from cover, hitting them off of high platforms, or using your persona's abilities to inflict status effects, your next unit will be able to down the same enemy by employing a similar follow-up tactic. Any unit that downs an enemy will earn a One More and get an extra bonus action that turn, as well as being able to move a second time. With the right skills, personas and strategy, it is often possible to chain several One More's together in just one turn, allowing you to effectively wipe out all of the enemy's units before they even manage to get two to three turns of their own.

The fact that your units can move infinitely within their allotted movement tiles before committing to an attack allows for a lot of freedom and experimentation, which in turn gives you the opportunity to find a way out of almost any situation, regardless of how dire things may appear.

Chaining up to fifteen moves in one turn using only three units never gets old either, particularly because it never feels too easy. Every super-long combo streak felt like a puzzle I had personally cracked, tactically weighing up every angle, rather than just a flashy moment the game had handed me. In fact, the sidequests outside of the main story literally are puzzles in this respect – most of them function as special challenges that require you to defeat up to 20 enemies within just one turn, helping to hone your instincts for normal battles.

I have poured roughly 80 hours into *Persona 5 Tactica* since I started playing it, completing two full playthroughs, crossing off every piece of side content and even completing the persona compendium, and I'm still not tired of its charms. And yet I'm still playing it, because the core combat is so much fun that improving my scores for every map still feels like a worthwhile endeavour.

1 The *Persona* crew love to strike a pose. Vogue!
2 *Tactica* picks up directly after the events of *Persona 5*.
3 And introduces new characters Erina and Toshiro.

Ryuji is great for dealing big damage.

VERDICT

★★★★½

This isn't just another well polished game in the Persona 5 line – it just might be the best Persona so far.
Lewis Parker

1

PRICE $44.95 **PLATFORM** PC, PS4/5, XB1/X/S, SWITCH **WEB** tinyurl.com/APC529ts

Thirsty Suitors

I've fallen head over heels.

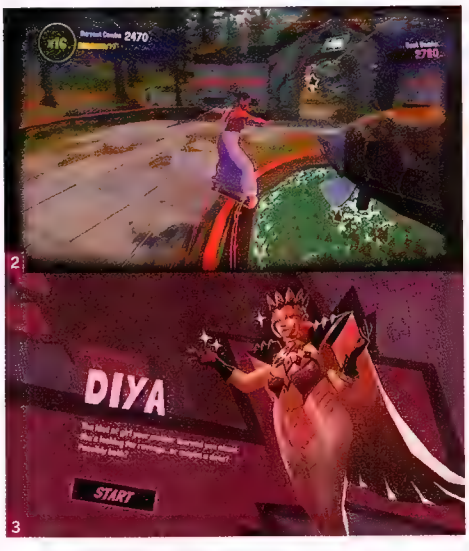
You're Jala, fresh from a nasty breakup and heading back to the hometown she abandoned several years ago. It's a narrative-heavy RPG, with a whole conga line of bitter exes waiting to face you. You're barely back in town before one forces you into a turn-based battle. Try not to get distracted by his abs.

You have a basic attack that costs nothing, a series of skills and summons that cost MP, and several taunts that open weak points. We've seen taunts like 'rage' in tons of games, but how about ones that leave the enemy emotionally devastated? It's hard not to giggle when the heartbreak taunt makes your ex burst melodramatically into tears.

Fights are constantly interrupted with verbal confrontations, as your ex calls out your past appalling behaviour, and you choose how to respond. Exchanges can get delightfully catty, but there's plenty of heart in the excellent script too.

Every ex encounter is brilliant. One is too timid to confront you directly, so his pet cat becomes a ferocious lion happy to strike you. Diya "exudes punk rock domme energy" and fights with a trio of crystalline backup dancers. Each battle concludes with you making up and deciding what your relationship will be going forward.

There's some simple cooking minigames, made more entertaining because you're cooking under the critical eye of Jala's mother. There's skateboarding, by the way – is perfectly solid arcadey fun. It's a neat way to get around town and there's even a skate park with a list of challenges.



2 3

It's all the little touches like that which make *Thirsty Suitors* special. Tutorial hints are given to you by your Uncle Hinti, a pun so horrible I want to applaud. Every night ends with you falling asleep on the sofa with your dad watching TV, and then he gently piggybacks you up to your bedroom. Jala may have been dreading returning to her hometown but I'm glad she made the trip. She's ended up starring in one of my favourite games of the year.

VERDICT

★★★★★

A heartfelt and hilarious couples therapy session, beautifully disguised as a stylish RPG. A gem.

Abbie Stone

1 Sergio is your most pathetic ex. It is a nice view, mind.
2 Watch out for the mean teens in the skatepark. They're merciless.
3 Each ex gets a joyously overblown entrance.

PRICE Free **PLATFORM** PC
WEB tinyurl.com/APC529mr

MOONRING

RINGING IN THE CHANGES.

The gaming landscape's been crying out for a game like *Moonring*: a retro-styled CRPG with a fascinating world and roguelike dungeons to tackle – but without the heartbreak of full permadeath. Die in a Moonring dungeon and you'll merely return to its entrance, albeit with all of your work undone. You can either enter it again in a newly generated maze, or wander off to another part of the (fixed) overworld.

Adventure arrives in the form of a cryptic note from your late father. Cryptic notes and snippets of conversation are how you'll learn anything in this delightfully old-fashioned game. Mainly you do this by talking to people, using a parser system to manually type conversation topics, before consulting the in-game notebook for a handy list of the things you've learned.

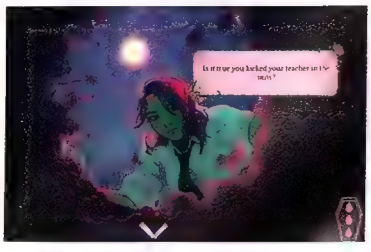
The game sings, for me, in its dungeons, which are atmospheric, turn-based delves into the unknown. It really is similar to a roguelike in that you're moving turn-by-turn, revealing the map and stepping onto traps, before monsters notice your presence and make a beeline for you.

VERDICT

★★★★½

Authentic, forward-thinking, and somehow free, *Moonring* modernises (sparingly) the classic CRPG.

Tom Sykes



PRICE Free **PLATFORM** PC, Mac, Linux
WEB tinyurl.com/APC529sb

STOP BURYING ME ALIVE, BEAUTIFUL!

RATS ABOUND...

Being buried alive is not normally something you get to enjoy more than once, but you'll want to at least replay the ending of this unusual visual novel that begins with your girlfriend covering you in dirt. See, she thinks you're dead, and it's surprisingly difficult to convince her you're not.

All you can do is speak to her, but alas, she's having none of it, as you pick from dialogue options to assert your aliveness. The grieving woman sees the act of burying you as a cathartic, healing experience.

Whenever the conversation sputters to a halt above ground, you need to duck your head under the earth to chat with the lady living in the plot next to yours. But what's she doing there? How is she living there? And does she even exist? *Stop Burying Me Alive, Beautiful!* isn't terribly interested in offering concrete answers, but she represents giving up on your above-ground girlfriend – so, if you choose to stay with her, you can live in a hole and stroke rats and play cards all day.

VERDICT

★★★☆☆

A wacky visual novel that takes a good idea in an unexpected direction.
Tom Sykes

1 What do you mean you gave away my copy of *APC* magazine?!
2 Now that's a reverse roundhouse kick!
3 Kiryu is a master of getting explosive results.

PRICE $82.95 **PLATFORM** PC, PS4/5, XB1/S/X **WEB** tinyurl.com/APC529dg

Like a Dragon Gaiden

A condensed adventure that brings a new purpose for Kiryu.

Like a Dragon Gaiden: The Man Who Erased His Name is not a 'major' release. It's a sidestory – one that bridges the gap in protagonist Kiryu's story between *Yakuza 6* and the upcoming *Like a Dragon: Infinite Wealth*.

As a result, it's shorter and less ambitious than a main series entry. There's very little here that feels new. The action is predominantly in Sotenbori – the series' take on Osaka's Dotonbori district, used frequently in previous games. The minigames are a tried and true collection of Yakuza classics, from mahjong to karaoke to the return of pocket circuit racing. There is one new location, The Castle – an absurd offshore getaway for rich hedonistic assholes. In practice, though, it's just a hub for the battle arena and a returning handful of gambling minigames.

Damn it, though, it still works. The nature of the series – its focus on story and character; on dramatic plot and absurd substories – makes every game something more than the sum of its distractions. Kiryu's return means we're back to the classic brawling that was once a staple of the series. And here, at least, there are some new toys to play with. Kiryu can switch between two combat styles: Yakuza and Agent.

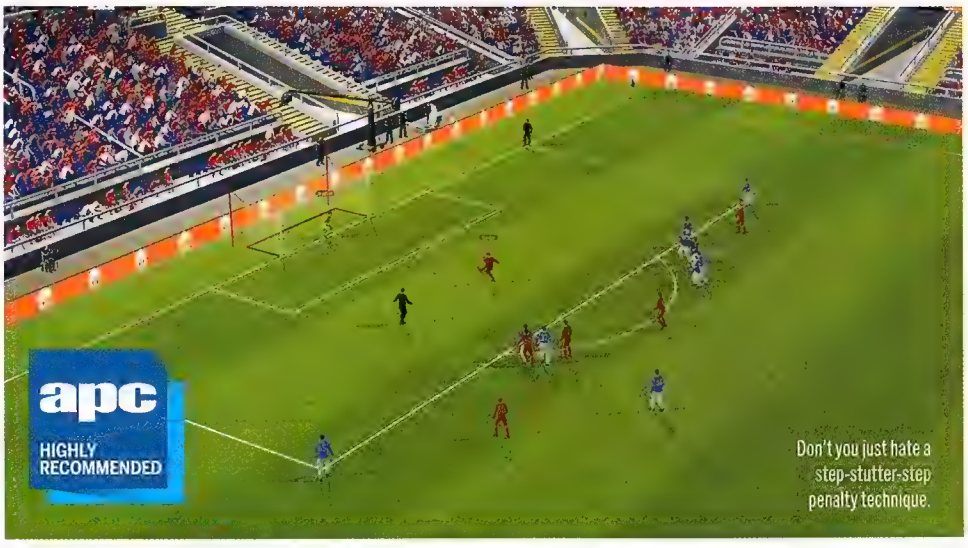
It's a shorter story than usual – just five chapters – but it achieves a lot in that time thanks to a supporting cast that remains nuanced and intriguing throughout. Kiryu's obligation to the Daidoji Faction is a particularly fascinating wrinkle, testing his sense of honour and the promise he made against his sense of honour and the bonds he still holds dear.

Gaiden's greatest strength is that it persuaded me that *Yakuza 6*'s unsatisfying lack of a definitive conclusion was actually the right move. That, as a character, Kiryu still has more to offer than just a cameo in someone else's story. The heartbreaking emotional gut punch of its conclusion means that, for the first time in a while, I'm excited to see what's next for the old dog and his new tricks.

VERDICT

★★★☆☆

Like a Dragon: Gaiden does little new, but its story is fascinating and heartbreaking in equal measure.
Phil Savage



PRICE $79.95 **PLATFORM** PC, XB1/S/X, PS5, Mac, Switch **WEB** footballmanager.com

Football Manager 2024

The most engrossing it's been for years.

What's new this year? Does it suddenly look like *FIFA*, or use Unreal Engine? Don't be silly. This is the same yin-yang of information-heavy menu screens and text-based interactions, giving way periodically to a 3D match engine where your tactical creations play out on the pitch. It's where late nights become troublingly early mornings and expletives are freely exchanged.

Coming off the back of a tough release last year which felt feature-light, *Football Manager 2024* wangs it top bins with its new additions. Creating specific set-piece plays is much easier this year. There's a set piece creation wizard now, like the formation and tactics wizard SI added a few games ago, which breaks down all the considerations of setting a corner procedure that actually works. You've been able to dictate whether your set-piece taker kicks an in-swinger or an out-swinger before, but by walking you through the creation step-by-step, *Football Manager 2024* makes it that bit easier to follow a consistent logic.

There's more feedback about your set pieces in-game too, and a greater focus on them in the way training data is presented. On the pitch, the player animations have really levelled up. Basic running animations look more natural. And the way players transition from running to turns, jumps, tackles or backtracking really catches your eye.

Criticisms of the match day presentation? I still don't use any of the sports data stuff like heatmaps with any regularity, and to be honest I find the sheer density of information overwhelming. I really don't feel like I need to see quite so much statistical data while the match is going on.

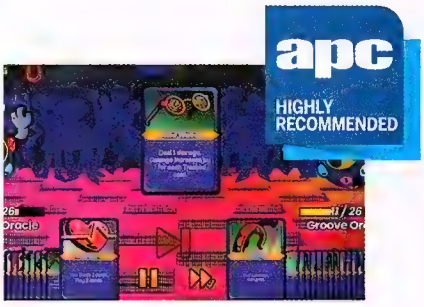
There are old annoyances here. It still takes too long to get a season done, and looking at the match engine stats display turns parts of my brain to liquid. But considering the scale of the project SI's taking on for *FM25*, this year's game feels genuinely additive. Crucially, it feels different and new on and off the pitch.

VERDICT

★★★★☆

Football Manager 2024 was never going to be a revolution, but you feel the new features on and off the pitch.
Phil Iwaniuk

1 Will Mourinho park the bus? Yes, yes he will.
2 Guy on the far left was late as he was reading *APC*.



PRICE Free **PLATFORM** PC, Mac, Linux
WEB megacrit.itch.io/dancing-duelists

DANCING DUELISTS

ENJOY A DISCO-THEMED DECKBUILDER.

Here's a new game by *Slay the Spire* devs Mega Crit, and it's a Street Fighter-style tournament. Beat seven opponents to win, but if you lose more than two matches, it's game over. Between each battle you will, of course, earn cards and trinkets. Build a synergy and soar to victory, or pile on cards and hope for the best.

Once the duellists are locked in the dance-off, you can't intervene. Your character automatically plays the next card from their randomly shuffled deck, and then your opponent plays theirs.

After so many years of copycats that have largely remained faithful to the Slay formula, it's a delight to finally play an actual *Mega Crit* follow-up. The on-the-fly synergising of *Slay* remains intact, only on a smaller scale, and at a much faster pace thanks to the hands-off battles. There are many more characters to choose from, compared to the four in *Slay*, and while their differences aren't nearly as stark, there are some fun character designs and deck quirks to get to grips with.

VERDICT

★★★★☆

A game that proves *Mega Crit* has still got it.
Tom Sykes

RELEASE 1999 & 2015 **DEVELOPER** Relic Entertainment **PUBLISHER** Sierra Studios **LINK** homeworldremastered.com

Homeworld

Ian Evenden heads back to 3D space and banana-shaped motherships in Relic's groundbreaking RTS.

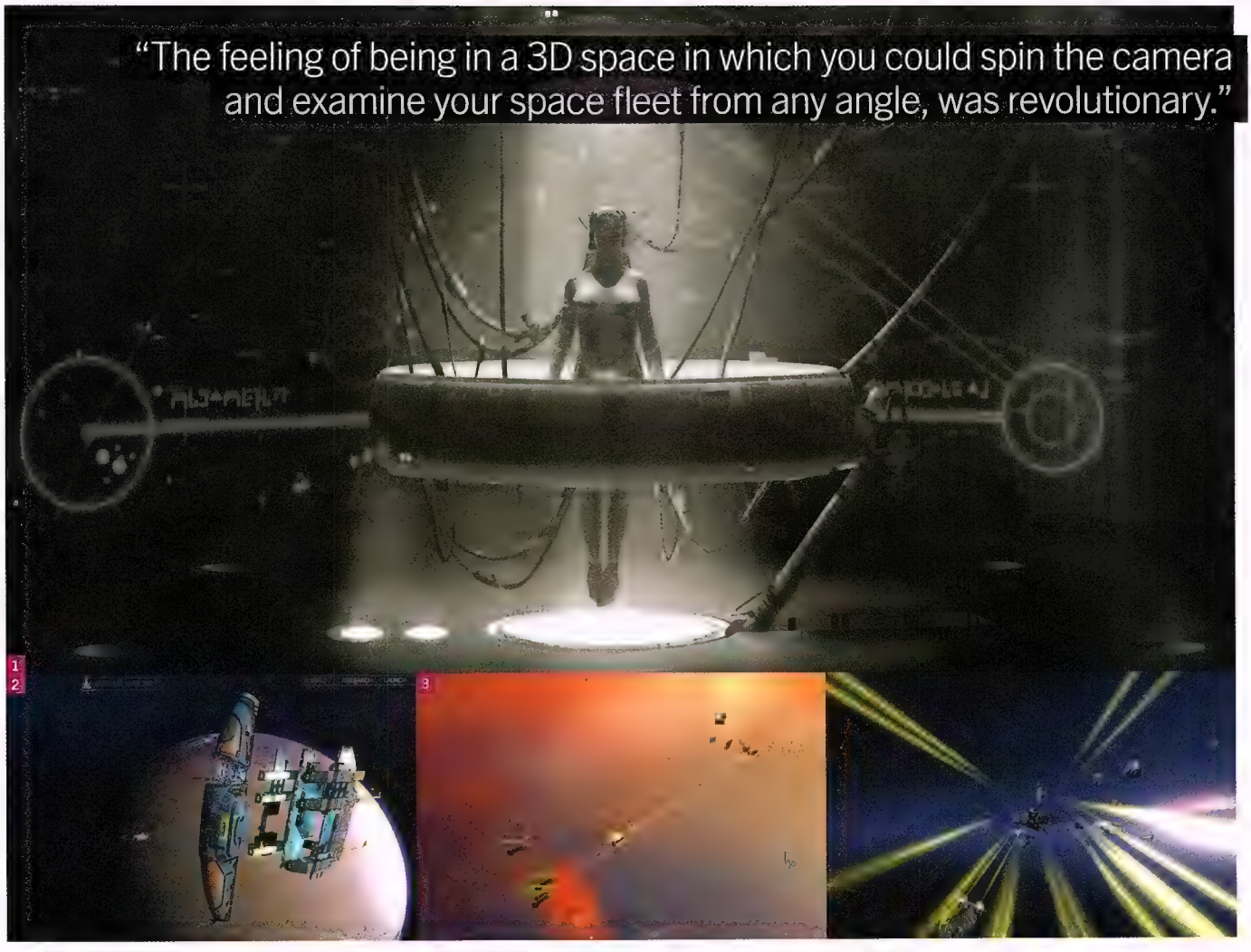
As the release of *Homeworld 3* nears, the original game remains an enigma. It's not directly available on Steam, or even GOG. To play it as it was you need the original discs and a PC that can accept them, and this means it hasn't had any official updates to allow it to run on modern machines. Unless you're one of those weirdos who keeps a 1999-spec PC in a special room with *The Matrix* and Red Hot Chili Peppers posters on the walls, there's a good chance you're not going to be able to play it.

Unless, of course, you install the remastered edition, which came out in 2015 and so practically counts as retro itself. That's what I'm reinstalling here, as my copy of the original disappeared years ago along with my *Matrix* posters. You can play the 'classic' version of the game through the remastered version's launcher, but I wouldn't recommend it: not only does it not support 16:9 resolutions, but turning the res up above 1999 levels brings all sorts of scaling issues on modern screens, rendering text pretty much unreadable.

The Steam version of the game also now comes with a splash screen advertising *Homeworld 3* and asking you to wishlist it, which completely filled my main 4K monitor and overflowed to my second screen, pushing any OK or close button off-screen somewhere I couldn't see. It necessitated a Win + Tab and closing it in the task switcher before I could even get to the launcher and start the game. Hopefully this will be patched out once the new game's released.

Spaced

The amazing thing, in 2023, is how fresh it all feels once you actually get into space. There was nothing like it in 1999, and relatively little to compare it to in 2015. There were plenty of RTS games in the '90s – *Age of Empires II* came out the same year – but they were earthbound things in which land, or occasionally water, units ran at one another in formations if you were lucky, or individually if you


"The feeling of being in a 3D space in which you could spin the camera and examine your space fleet from any angle, was revolutionary."

were being forced to micromanage. The feeling of being in a 3D space in which you could spin the camera and examine your space fleet from any angle, was revolutionary. A modern graphics card helps enormously here, the Voodoo 3s and early Nvidia cards at the time tried very hard, and it was the ideal game for showing off what your PC could do, but being able to play the game in 4K today trumps all of that.

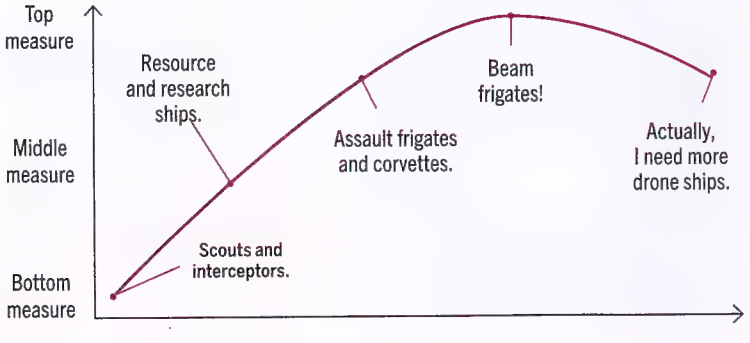
The problem with a true 3D space game is that it's complicated. Approaching a star base in *Elite Dangerous* from the wrong angle means not getting through the landing slot, so commanding a small force of fighters and frigates in *Homeworld* would be impossible, ships impossible to see or select because they were hidden behind a much larger craft, or just outside your viewport. Luckily you can set formations, select ships with a drag of the mouse as if they were icons on the desktop, or use the keyboard to select all combat ships and sic them on the enemy. It works, but with WASD bound to their own shortcuts, leaving the arrow keys and mouse to control the camera, the early missions are an exercise in getting to grips with the controls as much as testing your hyperspace drive. Rarely has there been a game in which the tutorials are so essential.

The story at first seems utopian. A set of warring clans on a desert planet dig up a crashed spaceship and with it a star map. This discovery unites the population and they spend 60 years building a mothership to take them to a place on the map marked as 'home'. Ten years before launch a

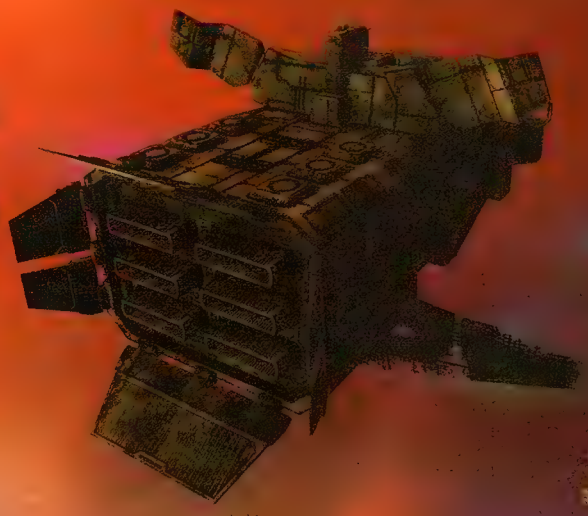
1 About as close as the game gets to a human face.
2 It's amazing what you can do if you work together.
3 Beam frigates! Attack!

BUILD QUEUE

THE PATH TO THE BEAM FRIGATE

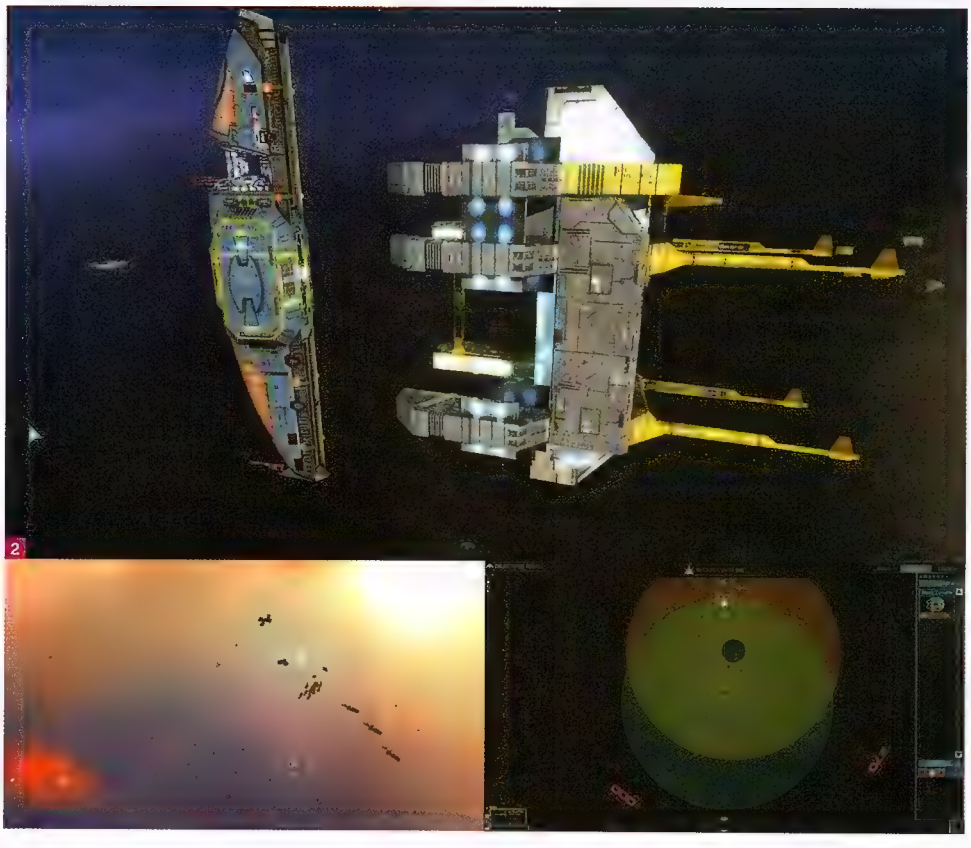


"If this game were made today, it would have a control scheme adapter for a controller, visual lists of ships from which you could pick the ones you wanted instead of relying on keyboard shortcuts to choose idle combat units or resource collectors."



resource ship sets off, just so it can be in the right place for a test of the hyperdrive. Karan S'jet sacrifices herself to become Fleet Command. It's all meticulously planned, and goes off without a hitch. Except the galaxy isn't amenable to the apparently benign exploratory ideas of the Kushan. They're attacked as soon as they leave their solar system, returning to their planet to find it razed, the remains of the population in orbiting cryopods that need to be defended. It gets worse, with the discovery that the Kushan are the bad guys, a former imperial power exiled to the desert world under penalty of death should they ever leave it. It wouldn't be an RTS without a few enemies, and *Homeworld* pits an entire galaxy against you.

If you've ever seen the heartbeat telemetry chart from Apollo 11's landing, which shows Buzz Aldrin – who wasn't at the controls – barely breaking a sweat as Neil Armstrong pilots the craft down and lands on the goddamn moon, you'll understand the vibe of the comms chatter. From the calm, smooth pronouncements of Fleet Command to the cool professional way your interceptor pilots announce they're going after enemy craft, or resource collectors tip you off that they've run out of space rubble to mine, the sense in *Homeworld* is that you're in charge of a well-oiled



1 An enemy that can take over your capital ships? Oh dear.
2 Ready to take on the universe.
3 These resource gatherers are the key to your fleet.

machine. The person playing the game, however, is rarely following the example of Dr Aldrin. A panic unique to the RTS sets in as you race to keep up with all the things tugging at your attention, from build queues to repairs to that phalanx of red dots approaching the mothership.

Happily, you get a decent range of toys with which to splat those red dots. You start with a few scout ships, which seem to be armed with the equivalent of muskets, taking so long between shots you can imagine the crew pouring powder down the barrel. They're effective to begin with, though, and open the door to heavy corvettes, guided missile frigates, the hilarious salvage frigates that can literally steal enemy ships and convert them to your side, and my favourite, the beam frigates, which are as close to glittering in the dark off the shoulder of Orion as you're going to get. There's a classic balancing act at play, with those beautiful beam frigates deadly against other large ships, but easily picked apart by a cloud of fighters, which you can guard against with drones or assault frigates, and so on.

Golden age

Playing *Homeworld* today drives one thing home hard: how good we have it. If this game were made today, it would have a control scheme adapter for a controller, visual lists of ships from which you could pick the ones you wanted instead of relying on keyboard shortcuts to choose idle combat units or resource collectors. The icons to switch between tactics and formations would be larger. You wouldn't have to hold Shift and the right mouse button – which is also bound to camera control – to choose options from a menu. Maybe you could zoom out to the tactical map using the mouse wheel rather than having to hit the spacebar. My favoured screenshot button wouldn't have a command attached to it that centres the camera on the mothership.

> "It could have been an office block, a Borg cube, the Pompidou Centre or a school gym block. But its designers chose to make it a space banana, an interstellar almond croissant, or perhaps a boomerang."

And it would also be full of people. One of the reasons *Homeworld* has aged so well, and weathered the remastering process to come out the other side looking like a new game, is that it keeps its human figures to cutscenes. Human faces from this period are deep in the uncanny valley at best, and absolute nightmares at worst. *Homeworld* sidesteps this as everything in the game itself is a machine, a lump of metal built to be functional rather than beautiful, and for which it doesn't matter if they're entirely made out of flat edges, and the recesses in their skin are textured on instead of being built into the 3D mesh.

Shape of things to come

Take the Kushan mothership, aka the Pride of Hiigara. It has no need to fly in an atmosphere, so it doesn't need wings or a sleek aerodynamic form. It could have been an office block, a Borg cube, the Pompidou Centre or a school gym block. But its designers chose to make it a space banana, an interstellar almond croissant, or perhaps a boomerang. It's a distinctive piece of design that rightfully made it to the cover art for the game. In my memory it's bright yellow, but appears grey in the remastered game, with yellow highlights around the door of its docking bay and what appear to be sections of wood panelling, though they might just be some advanced space materials.

This shape also plays a role in the game. Despite being 3D, missions generally play out in a flat 2D plane, and your vertical home is easily recognisable amongst the trails of fighters and the lances of beam frigates. Attack ships on fire are a common sight in *Homeworld*, but the trails they leave behind as they travel are another key part of its visual appeal. Not only do they help you to zero in on ships that might just be a point against the star field, but they allow you to differentiate between friends and enemies too.

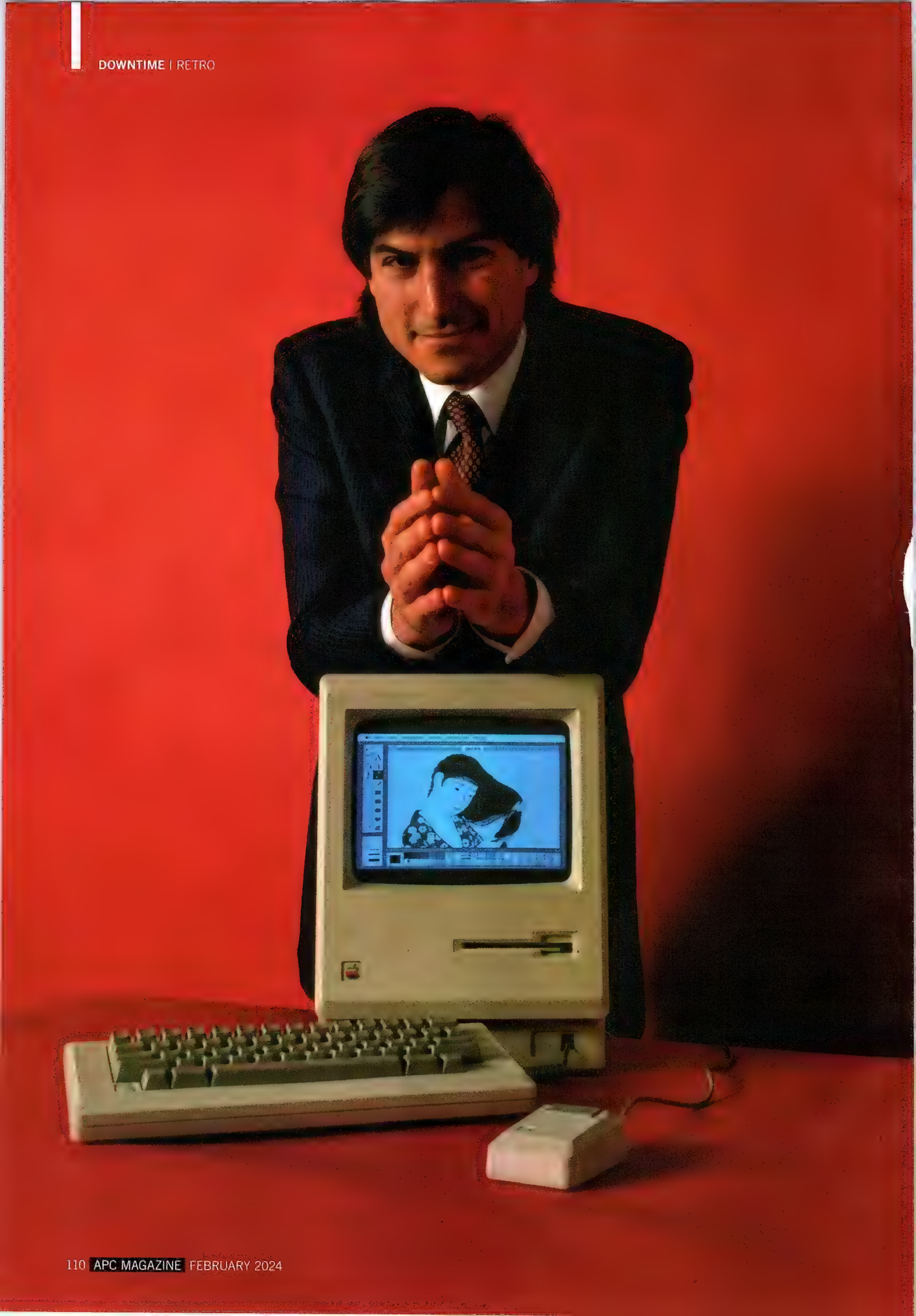
The remastered edition of *Homeworld* did so much to make a classic playable again. The continued interest in the series that's led to *Homeworld* 3 means it has never really left the collective PC gaming consciousness. The remastered edition was much needed, but nine years after its release it's beginning to show its age, and a new *Homeworld*, full of the things that make gaming great today, feels fitting for a series now clocking up a quarter-century. ■

FORM UP!
GROUP YOUR SHIPS IN PRETTY WAYS

1 THE WALL
The 3D equivalent to a line of musketmen. Can be effective against weaker enemies.

2 THE DELTA
Looks damned cool when you're travelling to your destination.

3 THE SPHERE
This one works best with a lot of fighters, otherwise it's just a jumble.



40 years of the Mac

Released in January 1984, the Apple Macintosh soon became an iconic machine, starting a range that continues to this day. **David Crookes** looks at how that first computer came to be.

It was director Ridley Scott who introduced the idea of the Macintosh to the world. His iconic commercial, *1984*, written by Steve Hayden, Lee Clow and Brent Thomas, was quickly acclaimed as a masterpiece, representing the Mac as a revolutionary product that could save humanity from conformity.

With more than a nod to George Orwell's classic novel of the same name, and aired during a Super Bowl break on 22 January 1984, it made consumers sit up and take notice. Within 100 days, this $1 million, 60-second ad helped Apple sell 72,000 Macs. But even then, no-one could have foreseen how much of a blockbuster the Mac would become.

The computer had been in development for quite some time. In 1979, Jef Raskin, who had joined Apple the previous year as employee number 31, had proposed an easy-to-use 8-bit computer, codenamed Annie, that he envisaged could sell for just $500 if it was designed well enough and was manufactured in high volume.

To help him achieve his aim, he created a team that included software developer Bud Tribble, computer engineer Burrell Smith and student Bill Atkinson, who would also work as a computer engineer. He also wrote a mission document called the Book of Macintosh – a play on the Book of Mormon. Raskin later joked that the tome had an anti-religious overtone.

The book was a collection of essays that went into detail about what the Macintosh should be. It was intended, Raskin wrote in May 1979, to be a "computer designed for the Person In The Street". To that end it would be a machine "that will be truly pleasant to use, that will require the user to do nothing that will threaten his or her perverse delight in being able to say: 'I don't know the first thing about computers'." It was also going to be "one which will be profitable to sell, service and provide software for".

That essay, Design Considerations for an Anthropophilic Computer, clearly stated that users shouldn't have to worry about what was inside the machine. Since Raskin didn't want anyone to ever have a need to see the interior, he therefore proposed that every add-on would be a separate appliance – a standalone device with its own case, sold as a complete item.

"Seeing the guts is taboo," he added. "Things in sockets is taboo (unless to make servicing cheaper without imposing too large an initial cost). Billions of keys on the keyboard is taboo. Computerese is taboo. Large manuals, or many of them (large manuals are a sure sign of bad design) is taboo. Self-instructional programs are NOT taboo."

BELOW The Apple Mac came with a keyboard and a one-button mouse.

A preliminary cost investigation in September 1979 showed the level of Raskin's ambition. A computer with a 6502 CPU and 64KB memory should, he stated, cost $125 to build, making an on-sale price of $500 feasible. He even believed it could go as low as $300 with increasing quantities. Such prices wouldn't include a display, disk drive or printer, however. These would need to be bought separately.

The following month, Raskin wrote about Steve Jobs, Apple's co-founder. He said Jobs had told him not to worry about price and to just specify the computer's abilities. "Starting with the abilities desired is nonsense," Raskin countered. "We must start with a price goal and a set of abilities and keep an eye on today's and the immediate future's technology."

A good job

Jobs wasn't part of the Macintosh team at this time. He was working on a desktop machine called Lisa. Development of this computer had begun in 1978 and it was very much a high-end affair – it ended up costing $9,995 when it launched in 1983, aimed at the business market.

For much of that time, Jobs had been hands-on. He worked on incorporating a similar mouse-driven GUI to the Xerox Alto and he was enthusiastic about the project. He strongly believed the Lisa would be a success thanks, in part, to the Lisa OS, bundled software, a Motorola 68000 CPU running at 5MHz and 1MB of RAM – far in excess of many other machines at the time.

But Jobs' overbearing nature and meddling saw him being kicked off the project in 1981. He began to look around for something else to sink his teeth into and spied an

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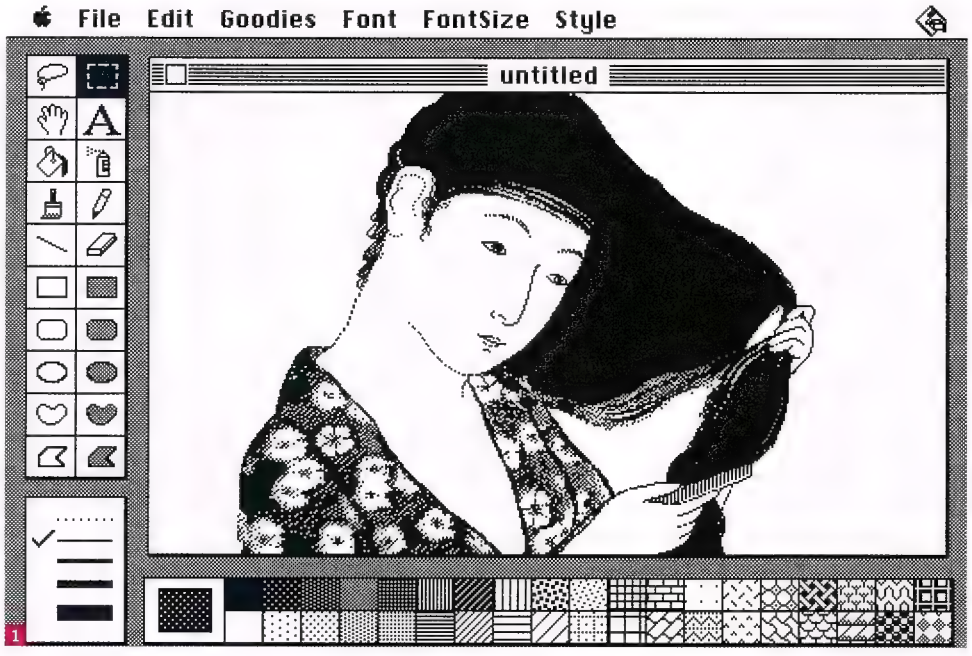


opportunity with the Macintosh, duly taking over the hardware side of development and seeking to put his own stamp on it.

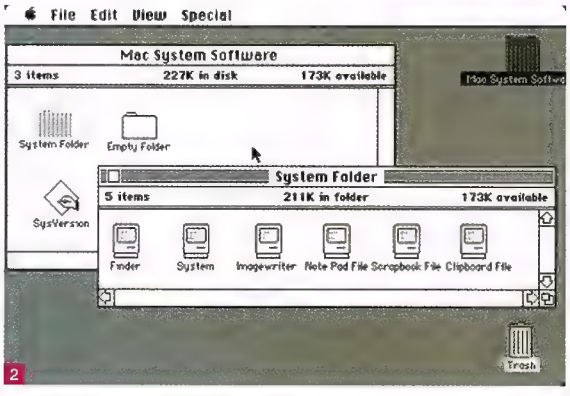
Raskin wasn't happy. It's said that Jobs eventually persuaded Apple's then CEO Michael Scott to allow him to lead the project. When Raskin left, he wrote an angry memo.

"While Mr Jobs's stated positions on management techniques are all quite noble and worthy, in practice he is a dreadful manager," Raskin said. "He is a prime example of a manager who takes the credit for his optimistic schedules and then blames the workers when deadlines are not met."

Even so, there's no denying that having Jobs on board was a positive move by Apple, no matter what motivated it. A decision had already been made to change the processor to the Motorola 68000 running at 8MHz, and the Macintosh was to add a black- and-white, 512 x 342 screen, a 3.5in floppy drive and double the memory to 128KB. Jobs brought a management style that encouraged those working on it to do the best they could.

Hard work

Burrell Smith was also an important part of the Macintosh's success. He'd been an Apple II service technician and he was recommended to Raskin after helping Atkinson add extra memory to the machine. Smith's



1 MacPaint was developed by Bill Atkinson with an interface designed by Susan Kare. 2 The System 1 GUI, which proved to be an instant hit.

ability to cut the number of chips while boosting performance was uncanny, although not quite enough to prevent the Macintosh from reaching a suggested price of $1,000 by 1980. Even so, he made the computer a far better product.

"I found it extremely easy to communicate with Burrell and part of that was that the turnaround time with Burrell for trying out new hardware ideas was like the turnaround time I was used to for trying out new software. He would do it overnight," said another member of the Macintosh design team, Bud Tribble, in a 1984 interview with *Byte* magazine.

"If I came up with an idea from the software standpoint and said to Burrell, 'wouldn't it be nice if we had this in the hardware?', he would come back the next day and say, 'we can do that if you make this slight change in the software'. In a very short time, we would get the whole thing going."

As if to demonstrate how hard Smith worked on the project, he designed five logic boards for the Macintosh. And, as time went by, more and more people joined the team. While it was still being treated as a sideline product by Apple, the hands-off approach by senior management seemed to work in the team's favour. They were able to work together in a small office and make their own decisions, producing a machine that ended up being very attractive to Apple.

Super system

Software was also very important. The Macintosh operating system, which became known as System 1, fell under the control of Hertzfeld, who also worked on the User Interface Toolbox, Windows Manager, Control Manager and Menu Managers. He says his first job on the team was to help verify that the disk controller was working properly, but the manner in which he ended up joining was unconventional.

"Steve came by my cubicle at Apple," he told the *Land of Giants* podcast, adding that a conversation ensued and he agreed to join the Macintosh team. Hertzfeld told Jobs he'd wrap up some documents and start on Monday. "He grabbed my Apple II off my desk and started walking away with it." Jobs had told him, "the Macintosh is the future of Apple. You're going to start on it now."

System 1 was groundbreaking. As well as having a GUI, it had features that would be part and parcel of Mac operating systems for years to come, among them Finder, overlapping windows, a clipboard, a Trash can, extras such as a calculator, control panel and clock, and a menu bar.

"The menu bar was a key feature that encouraged the user to discover, explore and access the range of commands available to them," Hertzfeld told *APC*. "The original Macintosh was also the first affordable computer that was relatively easy to use, thanks to its breakthrough graphic user interface."

The OS and Macintosh went hand in hand. "Without the system software, the Macintosh wouldn't

Making of a Mac

How the Macintosh appealed to consumers 40 years ago

1 GRAPHICAL USER INTERFACE
The Mac's mouse-driven operating system made its debut along with Finder and Trash.

2 THE INTERNALS
A 32-bit Motorola 68000, 128KB of RAM and 64KB of ROM were good enough for graphics work.

3 BUILT-IN MONITOR
The 9in black-and-white CRT monitor could display a one-bit graphical resolution of 512 x 342.

4 GOOD VENTING
The Macintosh didn't need a noisy fan, instead using vents on the casing.

5 FLOPPY DISKS
Each side of the floppy disk could hold 400KB, and the OS ran from a floppy rather than a hard drive.

be the Macintosh – it wouldn't exist," Hertzfeld added. He also said it had an impact on the wider industry. "The original Macintosh was widely copied, especially by Microsoft, and it elevated the entire PC industry," he said.

Instrumental in getting the look right was Susan Kare, Hertzfeld's old school friend. She became the screen graphics and digital font designer and was originally given an Apple II in exchange. "I was introduced to the project by Macintosh system software legend Andy Hertzfeld who knew I was really interested in graphics," she told APC.

"Andy recommended trying out some sample icons using graph paper, although after getting hired I transitioned immediately to an icon editor (written by Andy) that showed a 100% view and greatly enlarged view side-by-side."

Her work was varied. She decided to use scissors to symbolise a cut and she had an icon of a bin for the trash. Kare also created the iconic smiley face on a computer screen. She had no experience of creating computer graphics but she managed to work wonders in a 32 x 32 pixel square.

"I was influenced by all kinds of graphics, for example signage, folk art, needlepoint, mosaics (pseudo-digital techniques) and various symbol systems," she said. "As for my favourite, probably a tie between the smiling Mac and the watch."

How much?

All of this wrapped up into a winning machine. The Macintosh became known as the Mac in 1999. Colour had arrived in 1987, and Power Macintoshes heralded a move away from the Motorola 68000 series in the mid-1990s. But when it was released, the original Mac had blasted apart the value tag. It cost $2,495.

This disheartened the team. In an article written in 1993, Hertzfeld spoke of a price fight and a struggle to keep the Mac from jumping over the $1,500 price point. In the summer of 1983, he said, "we grudgingly accepted that the Macintosh would have to debut for $1,995", but CEO John Sculley was hired in April 1983 and the decision to market the Mac big time was not a cheap one.

Hertzfeld recalls the moment the high price was revealed. "Steve Jobs strode into the software area one evening, looking angry. 'You're not going to like this,' he told us, 'but Sculley is insisting that we charge $2,495 for the Mac instead of $1,995, and use the extra money for a bigger marketing budget. He figures that the early adopters will buy it no matter what the price. He also wants more of a cushion to protect Apple II sales. But don't worry, I'm not going to let him get away with it!'" As it happened, Jobs didn't have a choice.

On fire

Two days after the Mac advert aired during the Super Bowl, Jobs took to the stage to officially launch the Mac, and the price was indeed $2,495. "Today, one year after Lisa, we are introducing the third industry milestone product: Macintosh," he told the audience, the other two machines being Apple II and the IBM PC.

With Vangelis' musical score from Chariots of Fire playing, he pulled out the Macintosh, demonstrated its voice synthesis and the rest became history. For this was a machine that appeared to have it all. There was some amazing software such as MacPaint, among the first WYSIWYG art packages, and MacWrite, a WYSIWYG word processor. Together these applications set a bar for other packages to follow. It showed the Macintosh was a creative machine with solid real-life uses.

ABOVE The well-hidden Macintosh motherboard in all its glory.

Quite where Apple would be today without the Mac is anyone's guess. It's well known that Apple was in trouble in 1997 and that Bill Gates ended up pulling the company back from the brink of bankruptcy.

At the same time, Apple has kept apace with technology. "The Mac has run on four different processor families over the years: the 60000, the PowerPC, Intel and then finally Apple Silicon," said Hertzfeld. "Apple flawlessly executed each of those major transitions, which could have killed the company if it had been botched."

Indeed, it was a rejuvenated Mac that kickstarted a journey that put Apple back on the right path (the attractive iMac G3 in 1998 was, once again, a consumer desktop product aimed at the masses). "The most impactful advance was the switch to Next-based software around 2000," Hertzfeld added. And the iPod, iPhone, iPad and Apple Watch would likely never have got off the ground if the Mac had failed.

In many ways, the push for simplicity in Apple products today harks back to Ruskin's ethos: the strong belief that most people just want a computer that works when they turn it on – one that doesn't need to be messed around with internally in order to be upgraded or expanded.

When Apple sticks to user-friendliness, it seems to do well. Belief in the way of the Mac seems to have Apple's back. ■

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CHIP CHAT

Joel Burgess reports on the unusual side of tech news

© CD Projekt Red

TWITCH DEFINES NUDITY AND IT'S COMPLICATED

WHICH NUDE IS RUDE?

Twitch has been attempting to flesh out its nudity policies for some time now, instating new rules and limitations and sometimes even winding them back when there is more backlash than anticipated. The latest update to its line in the sand includes a clause for implied nudity, meaning people who are not even nude will be banned if their content features mostly naked individuals that have a clothed part of their genitalia obfuscated by an object or an edited blockout or blurring effect. This boundary is in place even if the content is flagged as containing 'sexual themes' and hidden from the homepage.

© Cocoa Press

COCOA PRESS CHOCOLATE 3D PRINTER

A GOLDEN TICKET TO OUT-OF-THE-BOX CHOCOLATIERING.

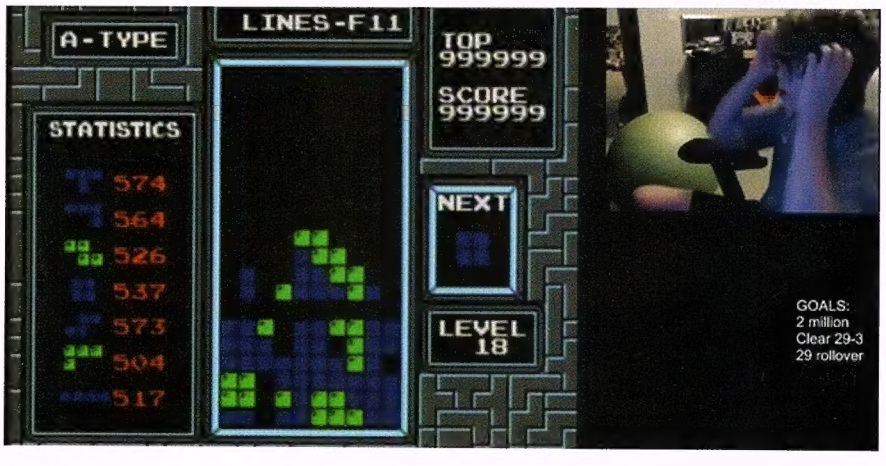
A new 3D printer that uses chocolate as its construction material is now available for anyone looking to explore the boundaries of chocolate creation. We suspect the market of budding Willy Wonkas probably isn't huge, especially considering the CAD skills you'll need to realise these dark dreams, but the possibilities are endless and could be the thing that puts you on the map. An edible Hot Wheels track or a red Porsche 911 Jaffa could almost justify the $1,499 asking price for some, but a freckle-based business plan to recoup costs is probably going to be required for most to pull the trigger on this one.

© Voicebot AI

Imprisoned Pakistani political figure uses AI to make campaign speech

Imran Khan leverages ElevenLabs voice clone tech to make an announcement.

Former Pakistani Prime Minister and cricketing legend Imran Khan has released his first public address since being imprisoned ahead of a trial for leaking classified documents. Khan was able to create the address thanks to a shorthand script smuggled out of the prison by lawyers that was read by an AI rendition of the public figure. The message encouraged his constituents to vote and was published widely on social media. The Pakistan Tehreek-e-Insaf party used ElevenLabs AI text to voice clone software that can imitate voices using speech samples.



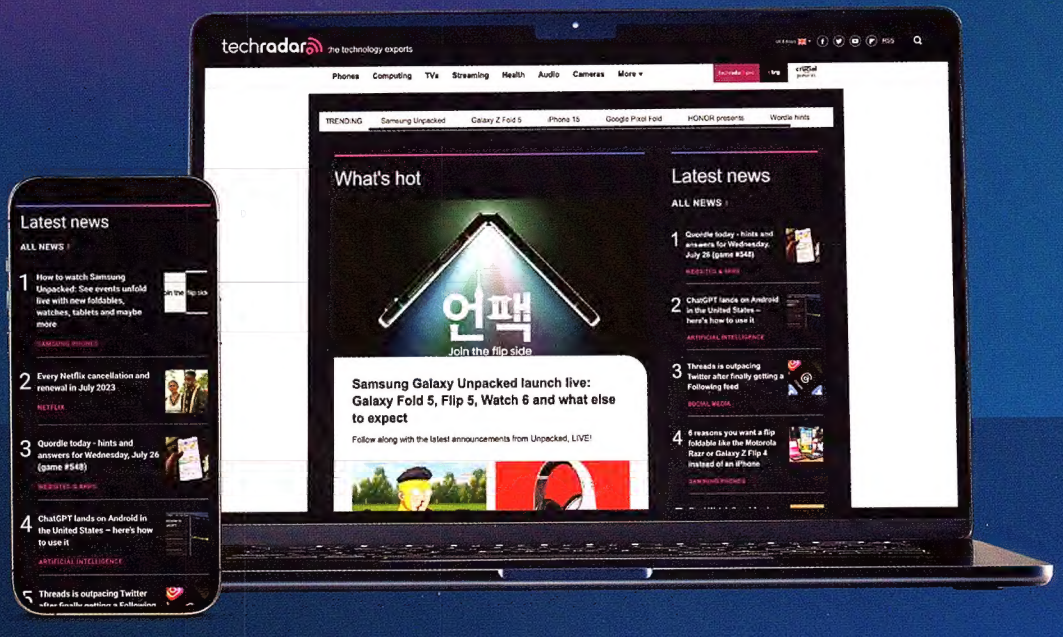
TETRIS BEATEN BY A HUMAN FOR THE FIRST TIME AFTER 34 YEARS

13-YEAR-OLD REACHES LEVEL 157 'KILL SCREEN'.

The 1989 NES (NTSC) version of *Tetris* has been played consistently since it was first released, but it was 'beaten' for the first time by a 13-year-old in December of 2023. The young *Tetris* phenomenon known as Blu Scuti managed to reach level 157 and clear a line of blocks resulting in the game crashing – and thus 'ending'. While *Tetris* Bot StackRabbit has made the game crash, Blu Scuti's recent score is was the highest level reached by a human to date and marks the first time the game has ever crashed under human control.

© Blu Scuti

Meet the technology experts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